

BRAZIL

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Brazil, which was the largest economy in the Mercado Comun del Cono Sur (Mercosur) and Latin America and the eighth largest worldwide with a population of more than 182 million inhabitants, had a gross domestic product (GDP) of \$451.0 billion,¹ or \$1.32 trillion in terms of purchasing power parity, in 2002. Brazil's GDP growth rate was 1.5% compared with 1.7% in 2001. Foreign exchange reserves increased to about \$37.82 billion from \$35.86 billion in 2001 and the peak level of \$51.4 billion in 1997. Brazil's total debt burden amounted to \$222.4 billion. The trade balance increased substantially to a new peak level of \$13.2 billion surplus compared with \$2.7 billion in 2001. Exports were valued at \$60.4 billion, and imports totaled \$47.2 billion. The growth of Brazil's economy slowed in 2002 because of a slowdown in the global economy, which was mostly in the major markets of Europe, Japan, and the United States, and the increasing of interest rates by the Brazilian Central Bank to fight inflationary pressures. Inflation was 8.3% compared with 7.7% in 2001. The devaluation of Brazil's real helped moderate the downturn in economic growth during 2001 and 2002, which was strongly affected by the domestic electricity rationing, the Argentine economic crisis, and the aftermath of September 11 (Departamento Nacional de Produção Mineral, 2003a, p. 9-10; Ferraz, 2003, p. 1; Banco Central do Brasil, 2003a§;² U.S. Central Intelligence Agency, 2003§).

In 2002, foreign direct investment (FDI) inflows to the Latin American and Caribbean region decreased to \$35.6 billion in 2002 from about \$79.7 billion in 2001. Brazil's share of the region's net FDI inflows decreased to \$16.6 billion in 2002 from \$22.5 billion in 2001. This reduction was strongly impacted by Brazil's country risk owing to the Brazilian electoral process and Argentina's somehow worsening economic crisis, which made Mercosur less attractive to foreign investment (Economic Commission for Latin America and the Caribbean, 2002a, b§; Banco Central do Brasil, 2003b§).

The International Monetary Fund endorsed Brazil's move to a system of inflation targets and currency devaluation to guide its monetary policy between 2002 and 2003. This action indicated that the country could reduce its account deficit to \$26.2 billion from \$35.2 billion in 2002, which would be equivalent to 5.8% of the GDP, thus helping restore confidence in the Government's economic management and creating conditions for lower interest rates and economic recovery (Banco Central do Brasil, 2003c§).

The Brazilian strategic plan Plano Real continued to be based on constitutional reviews, joint ventures with the private sector

¹Where necessary, values have been converted from Brazilian real (R\$) to U.S. dollars at the rate of R\$3.531=US\$1.00.

²References that include a section mark (§) are found in the Internet References Cited section.

in the hydrocarbons industry, and macroeconomics to achieve its goals and to encourage additional capital flows into the country's economy. Given that the economy was in recovery, however, the currency devaluation and a tough fiscal austerity plan helped restore confidence in the new Government's economic management and create favorable conditions for lower interest rates and Brazil's economic recovery in the foreseeable future, mostly from 2003 through 2005 (World Bank Group, 2002§; Departamento Nacional de Produção Mineral, 2003a, p. 11, 16; Banco Central do Brasil, 2003a§).

In 2002, Brazil's trade balance was \$13.1 billion compared with \$2.6 billion in 2001. The mineral sector had a surplus of \$2.8 billion compared with a deficit of \$681 million in 2001; if coal, natural gas, and petroleum and its derivatives were excluded, however, then the surplus would have been \$7.9 billion (Departamento Nacional de Produção Mineral, 2003a, p. 16-17).

Brazil produced 72 mineral commodities (46 industrial minerals, 22 metals, and 4 fuel minerals), 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 2002. In Latin America, particularly within Mercosur, Brazil continued to be the leading producer of aluminum, cement, ferroalloys, gold, iron ore, manganese, steel, and tin. Brazil's reportedly large mineral reserves and other identified resources helped make it one of the most dynamic markets in the world and one-third of the Latin American economy (Departamento Nacional de Produção Mineral, 2003a, p. 11-12). The country continued with its petroleum exploration program to expand reserves as well as to reduce dependence on oil imports, which satisfied about 22.4% of its crude oil requirements (Departamento Nacional de Produção Mineral, 2003d, p. 103; Petróleo Brasileiro S.A., 2003, p. 4).

Brazil's petroleum and mining industries and utilities attracted investor interest because of the country's diversified minerals endowment, the Government's macroeconomic policies, and a skilled labor force. Major international mining, petroleum, and steel companies were notably interested in, in order of importance, oil and gas, iron ore, steel, coal, gold, copper, and diamond.

The past megamergers of British Petroleum Ltd. of the United Kingdom and Amoco Corp. (BP Amoco) in 1998, Exxon Corporation and Mobil Oil Corp. (ExxonMobil Corporation) in 1999, Chevron Corp. and Texaco Corp. (ChevronTexaco Corp.) of the United States, and others in 2001 entered into joint-venture oil-gas projects with Petróleo Brasileiro S.A. (Petrobrás). In 2002, Petrobrás viewed these joint ventures as significant to the improvement and strengthening the economy of scales, competitiveness, and operational synergy, which

will affect future oil-gas joint ventures between Petrobrás and the private sector. Equally important to Brazil was the Minas Gerais iron ore joint venture between Companhia Vale do Rio Doce (CVRD) and China's Shanghai Baosteel Group Corp. and the Sossego copper-gold joint venture between CVRD and Phelps Dodge Corp. of the United States (Ferraz, 2003, p. 1-2). Since 1991, the more than 500 transnational corporations that have established operations in Brazil have brought in about \$250 billion in registered investment with the Banco Central do Brasil; of that total, about \$60.0 billion was received by the minerals sector. The Banco Central do Brasil (2003b§) also reported that since 1996, the accumulated net FDI amounted to about \$140 billion as equity capital, of which \$35 billion was used for acquisitions of state-owned assets and \$105 billion (excluded privatizations) was for direct investment and joint ventures with the private sector.

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 Corporation, INCO Limited, and TVX Gold Inc. of Canada; Shanghai Baosteel Group Corp. of China; EDP of Portugal; Anglo American plc, BHP Billiton plc, and Rio Tinto plc of the United Kingdom; Iberdrola S.A. of Spain; and ChevronTexaco (ChevronTexaco Brasil S.A.), Dow Chemical Co., Enron Energy Corp., ExxonMobil (Esso Brasileira de Petróleo Ltda.), Newmont Mining Corp., and Placer Dome U.S. Inc., of the United States; and Royal Dutch/Shell Group of Companies of the Netherlands (Departamento Nacional de Produção Mineral, 2003d, p. 103).

Government Policies and Programs

The legal framework for the development and use of mineral resources in Brazil was established by the Federal Constitution, which was 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 joint ventures and/or privatization investment in the sectors of mining, natural gas, and petroleum and in the deregulated sectors of coastal and river shipping, telecommunications, and transportation. The Government monopolies of the oil and gas industries and fuel price subsidies, which were rescinded in 1999 after 45 years, allowed Petrobrás to enter into joint ventures with foreign investors. The Agência Nacional do Petróleo, however, regulates the petroleum industry (Ferraz, 2003, p. 9; Pimentel, 2003a, p. 3-5). Since 2001, the Government reduced the Brazilian import tax for minerals; the rates vary from 3% to 9%—ores and concentrates are 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; the tax rate ranges between 10% and 15% and is levied on gross profit. Profits can be expatriated. Equity ownership, which is allowed via privatization or by direct acquisition, can be as high as 100% (Pimentel, 2003b, p. 10-15; Departamento Nacional de Produção Mineral, 2003c, p. 5-8). In 2001, the Concessions

Law created additional opportunities for the private sector in public utilities previously reserved for the Government.

All the above actions, which were undertaken by the Government to open the Brazilian economy to international competition, have continued to create an environment that attracts domestic and foreign investments equally. The establishment of joint ventures in the sectors of construction and management of railroads, ports, telecommunications, and hydroelectric power plants; metals; and oil and gas has become a common practice in Brazil.

The Brazilian Constitution and the Mining Code, law No. 9314 of January 1997, provide 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 Departamento Nacional de Produção Mineral (DNPM) and a development concession issued by the Minister of Minas e Energia. Licensing is a restricted system applicable exclusively to the exploitation of industrial minerals. The DNPM is responsible for enforcing this Mining Code and its complementary legal provisions. In 2002, the DNPM issued 9,309 exploration licenses compared with 11,225 in 2001 and reported an investment of \$200 million in mineral exploration compared with \$180 million in 2001 and \$104 million in 2000. Companhia de Pesquisa de Recursos Minerais (CPRM) (the Brazilian Geological Survey) is 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 databases, particularly for coal, copper, diamond, gold, kaolin, nickel, peat, and zinc, to assist potential investors in the minerals sector.

In Brazil, *Compensação Financeira pela Exploração de Recursos Minerais* (CFEM), which is a financial compensation [permitting proceeds] for exploring mineral resources, was established by the Brazilian Constitution of 1988 and instituted by law No. 7,990 in 1989. The Municipalities, States and Federal Government's direct administrative departments share CFEM in the proportion of 65%, 23%, and 12%, respectively. In July 2000, the Federal Government decided to share its CFEM income (law No. 9,993/2000) with the National Fund for Scientific and Technological Development (FNDCT), which is an instrument for technological innovation for the benefit of all Brazil's productive sectors. The FNDCT will receive a 3% share of all permitting proceeds. The CFEM collection from 1997 through 2002 was very successful and grew at the rate of 20% per year. The first year of collection (2001) reached \$161 million, or 15.7% higher than the expected \$144 million, the second year (2002) of collection was \$186.2 million, the third year (2003) of collection was \$223.4 million, and the fourth year (2004) was expected to be \$300 million (Departamento Nacional de Produção Mineral, 2003a, p. 27-28).

In 2002, the States of Minas Gerais (43%) and Pará (27%) were the major collectors of CFEM; the main participating Municipalities were Parauapebas (17%) and Oriximiná (7%) in Pará and Itabira (14%) and Nova Lima (5%) in Minas Gerais. Both States and their respective Municipalities were the main producers of iron ore (46%), aluminum (9%), and manganese, kaolin, and gold (4% each) (Departamento Nacional de Produção Mineral, 2003a, p. 29-30).

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 the MMA is the Conselho Nacional de Meio Ambiente, which grants the environmental licenses that are 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 that they have environmentally degraded. 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). An EIA applies to mining projects of any mineral substance; an LA is mandatory for installing, expanding, and operating any mining activity under the systems of mining concession or licensing; and a PRAD requires suitable technical solutions to rehabilitate the soil and other aspects of the environment that might be degraded by mining operations (Departamento Nacional de Produção Mineral, 2003b, p. 35-38). The Ministério de Minas e Energia enforces the 1989 decree, which prohibits the use of cyanide and mercury in the mining of gold unless approved by local Brazilian environmental agencies and offers technical assistance on producing gold without affecting the environment to small-scale independent miners (*garimpeiros*), in particular. Environmental impacts are expected to be minimized in the long run.

Resolution 010 of December 6, 1990, requires that all mining operations obtain LAs 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

In 2002, the total value of minerals produced (gas and crude oil included) was about \$12.9 billion, or about 2.9% of the GDP. The minerals-based industries amounted to \$38 billion, or about 8.4% of the GDP. Crude oil and natural gas amounted to almost \$6 billion. Mineral production contributed 10.4% of the GDP in 2002 compared with 3.4% in 2001 because the electricity rationing ended and the minerals sector performance increased during the second half of 2002. Depletion of shallow gold and tin deposits and environmental constraints on *garimpeiros* affected their output of gold and tin (Departamento Nacional de Produção Mineral, 2003a, p. 11; Banco Central do Brasil, 2003c§).

The major integrated steelworks were the structure and rail producer Aço Minas Gerais, S.A., Latin America's largest integrated steelmaker Companhia Siderúrgica Nacional (CSN), the carbon steel sheet and plate producer Companhia Siderúrgica Paulista, the slab producer Companhia Siderúrgica de Tubarão, and Brazil's second largest steel mill Usinas

Siderúrgicas de Minas Gerais, S.A. These companies produced about 18.5 million metric tons (Mt), or about 64% of the total Brazilian steel production of 29.6 Mt (Departamento Nacional de Produção Mineral, 2003d, p. 72). Brazil remained the largest iron ore producer in the world with a flat output of 251.4 Mt. CVRD produced about 74.5% of the iron ore (Departamento Nacional de Produção Mineral, 2003d, p. 70). 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 75.2% of the total bauxite production, which amounted to about 13.2 Mt in 2002. The four major aluminum smelters, Albras-Alumínio Brasileiro S.A., Alcoa Alumínio S.A., Companhia Brasileira de Alumínio, and Billiton Metais S.A., produced 88.4% of the primary aluminum production of 1.32 Mt (table 1; Departamento Nacional de Produção Mineral, 2003d, p. 36).

Trade

Brazil was the largest open market in and the economic center of Mercosur. In 2002, the member countries of Mercosur had almost 247 million people, or 27.1% of the Western Hemisphere's population, and a combined purchasing power parity of almost \$2.02 trillion, or about 77.8% of South America's total purchasing power parity. Brazil accounted for about 71% of Mercosur's population and about 66% of its purchasing power parity (U.S. Central Intelligence Agency, 2003§). Most multinational companies considered this growing trade bloc, which was behind the North American Free Trade Agreement (NAFTA) and the European Union, to be extremely important because of its size and the amount of trade that takes place in the region. NAFTA has had an impact on Latin America and Caribbean Basin trade, which increased to about \$109 billion, or about 58% higher than that of 1991 (\$63 billion). When Mercosur is fully integrated, unrestricted movement of goods, labor, and services is expected to take place among the four principal members and the two associate members. Mercosur has had an affect on intraregional trade, which increased to about \$30 billion in 2001 from \$7 billion in 1983. Intra-Mercosur trade amounted to \$25 billion, and mineral trade amounted to \$1.8 billion (Departamento Nacional de Produção Mineral, 2003a, p. 12-13).

In 2002, Brazil sold 17% of its exports to the other Mercosur members and 26% to the other countries in Latin America. Total minerals trade between the major players of Mercosur, Brazil (\$1.1 billion) and Argentina (\$700 million), amounted to \$1.8 billion. Brazilian mineral imports were valued at \$11.3 billion, or almost 11.0% lower than those of 2001 (\$12.7 billion), and its total mineral exports were \$14.2 billion, or about 17.4% higher than those of 2001 (\$12.1 billion). The values of the principal exports were \$3.0 billion for iron ore; \$2.9 billion, steel products; and \$1.3 billion, aluminum. In addition to petroleum and derivatives and natural gas (\$6.5 billion), other major mineral imports (\$4.2 billion) were, in order of importance, coal, potash, phosphate rock, copper, salt, zinc, and others (Departamento Nacional de Produção Mineral, 2003a, p. 25-26; Ferraz, 2003, p. 11).

Brazil-U.S. trade relations during the past decade grew at an unprecedented rate. The U.S. imports were primarily

manufactured and semimanufactured 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, which were, in order of importance, iron ore, manganese, marble, granite, and agricultural commodities.

In 2002, total mineral trade between Brazil and the United States was \$4.5 billion. Exports increased slightly by 3.3% to \$3.4 billion, and imports decreased by about 20.1% to \$1.1 billion. Brazil's mineral trade balance with the United States increased to a surplus of \$2.3 billion from a surplus of \$1.9 billion in 2001 (Departamento Nacional de Produção Mineral, 2003a, p. 22).

Structure of the Mineral Industry

The mineral industry of Brazil was large by world standards. Brazilian corporations, private Brazilian investors, and/or foreign companies partially or wholly owned the major portion of the industry. The exceptions were the natural gas and petroleum industries, which were 100% Government owned through Petrobrás, which comprised five subsidiaries—Petrobrás Distribuidora S.A. was the petroleum products distribution company; Petrobrás Internacional, S.A. was the foreign operating company; Petrobrás Transporte S.A. was 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. was the integrated refining-petrochemical operations company; and Petrobrás Gás S.A. was the producing, trading, and distributing of natural and liquefied natural gas, and fertilizers company (Petróleo Brasileiro S.A., 2003, p. 10-29).

The structure of the Brazilian mineral industry continued to change to a privately owned/Government-regulated regime from one that was Government owned/Government operated. Between 1991 and 2002, the Government privatized CVRD, the electrical energy and telecommunications sectors, and the steel industry. In addition, 40 cement companies were operating 64 cement plants and 7 grinding plants with a clinker capacity of 45 Mt in 22 States, and 30 iron ore mining companies were operating 80 mines and 43 processing plants (Departamento Nacional de Produção Mineral, 2003d, p. 52-70).

In 2002, Brazil's total labor force was nearly 80 million. Of this total, services represented 53%; industry, 24%; and agriculture, 23%. The unemployment rate was 6.4% (U.S. Central Intelligence Agency, 2003§). The minerals sector employed about 5% (960,000) of the industry total (19.2 million); this did not include the nearly 650,000 active garimpeiros (Vale, 2003, p. 1). Employment in the mining sector continued its downward trend as Brazil's economy was affected by its recent slow economic recovery, the Argentinean crisis, and the increases of efficiencies and productivities in the private sector that resulted from the joint ventures, mergers, and privatizations, particularly in the mining and steel sectors (table 2).

Commodity Review

Metals

Alumina, Aluminum, and Bauxite.—Alumina production was about 4.0 Mt, which was about 15.0% higher than that of 2001. Alumínio do Norte do Brasil S.A. (Alunorte) produced 44.5%; a consortium of Alcoa Alumínio S.A. (54%), BHP Billiton (36%), and Alcan Alumínio do Brasil S.A. (10%), 41.2%; and Companhia Brasileira de Alumínio (CBA), 13.3%. Exports were 1.13 Mt valued at \$171 million. CBA planned to invest \$700 million to produce 500,000 metric tons per year (t/yr) of alumina and to expand its aluminum capacity to 340,000 t/yr from 240,000 t/yr by 2003. In 2002, the Alunorte alumina refinery operated by a consortium of Vale do Sul Alumínio S.A. (Aluvale) (57.03%), Norsk Hydro Comercio e Industria (34.03%), Nippon Amazon Aluminum Co. (4.05%), CBA (3.62%), and others (1.27%) sold 1.59 Mt of alumina (Departamento Nacional de Produção Mineral, 2003d, p. 37; Ferraz, 2003, p. 2-3).

Primary aluminum production amounted to about 1.31 Mt of metal, or 16.2% higher than that of 2001. Primary aluminum producers were Albras-Alumínio Brasileiro S.A. (Albras) (Aluvale, 51%, and Japanese companies, 49%) produced 417,120 metric tons (t); Alcoa, 285,120 t; CBA, 249,480 t; BHP Billiton, 215,160 t; Alcan, 100,320 t; and Aluvale, 52,800 t. The Alumar smelter (Alcoa, 53.66%, and BHP Billiton, 46.34%) at São Paulo produced 248,800 t; the Valesul plant (Aluvale, 54.5%, and BHP Billiton, 45.5%) at Santa Cruz, Rio de Janeiro, 92,900 t; the Alcoa plant at Poços de Caldas, Minas Gerais, 87,400 t; and the pipeline facilities at Aratu, Bahia, and Alcan's at Ouro Preto in Minas Gerais produced 52,500 t and 49,500 t, respectively. In 2002, Brazil imported 122,916 t of all forms of aluminum valued at \$365,000 million; this was 10% less than in 2001. Exports were 865,000 t valued at \$1.26 billion; this was 20% higher than in 2001 (Departamento Nacional de Produção Mineral, 2003d, p. 36; Ferraz, 2003, p. 3).

Bauxite production was 18.2 Mt, which was about 32% higher than that of the previous year. The MRN joint venture, which was owned by CVRD (40%), Billiton plc (14.8%), Alcoa (13.2%), Alcan (12%), CBA (10%), Norsk Hydro (5%), and Reynolds Alumínio do Brasil (5%) accounted for about 78.0% of the total bauxite production (14.2 Mt) for 2002. Exports amounted to 3.4 Mt of bauxite valued at \$91 million, 1.1 Mt of alumina valued at \$171 million, and about 1.0 Mt of primary aluminum valued at \$1.3 billion (Departamento Nacional de Produção Mineral, 2003d, p. 36-37; Ferraz, 2003, p. 2-3).

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. The Papagalo Mine will maintain MRN's total bauxite ore production capacity at about 16.3 Mt/yr. CVRD was planning to invest \$320 million in the Paragominas bauxite mine, which contains 878 Mt of reserves, to produce 4.5 Mt/yr by 2005. The Albras facility at Vila do Conde, Pará (CVRD, 51%, and Nippon Amazon Aluminum Co., 49%), produced 369,200 t of primary

metal in 2002, and was to be expanded to 400,000 t/yr capacity at a cost of about \$100 million in the near future. Alcan invested \$370 million in expansions of its complex facility at Laminação de Pindamonhangaba in São Paulo to increase its production capacity to 280,000 t/yr from 120,000 t/yr in 2001. The Alcoa aluminum smelter was expanded to 239,000 t/yr from 194,000 t/yr in 2001 at a cost of \$550 million. Alcan expanded its aluminum sheet production capacity to 120,000 t/yr from 100,000 t/yr in 2001, as a part of a \$380 million investment program and was planning to increase its primary capacity to 150,000 t/yr by 2003. Investments in the aluminum sector could reach up to \$1.6 billion within the next few years. Latapack-Ball S.A., which produced aluminum cans, invested \$5 million to increase its plant capacity in Jacareí, São Paulo, to 2 billion aluminum cans from 1.7 billion. Brazil recycled 87% of all the aluminum cans, which was equivalent to 121,100 t of aluminum cans, or about 9 billion units; this was an increase of 2.6% compared with that of 2001 (Ferraz, 2003, p. 3).

Columbium (Niobium) and Tantalum.—Brazil continued to be the world's most significant producer and main supplier of columbium (niobium) to the global markets. In 2002, Brazil produced about 95.1% of the world's total output, or 41,303 t of pyrochlore (Nb_2O_5) in concentrates, 24,174 t of columbium (niobium) in alloys, and 2,371 t of columbium (niobium) in oxides from two open pits located in Araxá, State of Minas Gerais, and Catalão, State of Goiás. In 2002, Mineração Catalão de Goiás Ltda. (MCGL) (a joint venture of Bozzano Simonsen S.A. of Brazil, 68.5%, and Anglo American, 31.5%) and Companhia Brasileira de Metalurgia e Mineração (CBMM) (a joint venture of Grupo Moreira Sales S.A. of Brazil, 55%, and Molycorp, Inc. of the United States, 45%) accounted for 61.5% and 38.5%, respectively, of Brazil's 65,000-t/yr pyrochlore production capacity. The columbium (niobium) plants of CBMM in Araxá and MCGL in Ovidor accounted for about 88% of Brazil's pyrochlore production and supplied about 79% of the world demand for ferrocolumbium. The Araxá, the Catalão, and the Ovidor columbium (niobium) ore deposits contained 97.8% (5.2 Mt) of the world's pyrochlore reserves. In 2002, Araxá alone produced 35,083 t (Nb_2O_5 content) in concentrates (Departamento Nacional de Produção Mineral, 2003d, p. 96).

In 2002, tantalum production totaled 231 t (Ta_2O_5 content) in concentrates. The Pitinga Mine, which was considered to be one of the world's largest (88,760 t Ta_2O_5) and most economically viable ore body, produced 148 t, or 64%, of Brazil's tantalum output. The upward trend in tantalum supply will continue in response to increased world demand (Departamento Nacional de Produção Mineral, 2003d, p. 116-117).

Copper.—Copper concentrate production amounted to 30,642 t, which was a very small increase (1.8%) compared with that of 2001 (30,111 t). The concentrate was produced by Mineração Caraíba S/A's deposit in Jaguarari, State of Bahia, which was Brazil's only underground copper mine and owned by Grupo PARANAPANEMA (GP) (Departamento Nacional de

Produção Mineral, 2003d, p. 54; Ferraz, 2003, p. 5).

In 2002, Caraíba Metais S/A (CMSA) of Camaçari, Bahia, which was the only electrolytic copper producer in Brazil, produced 189,651 t of primary copper metal; this was a decrease of 10.6% compared with that of 2001, and included 463,124 t of copper concentrates imported from Chile (75%), Peru (8%), and other countries (17%). CMSA, in order to meet Brazil's metal copper demand of 255,251 t/yr, imported 125,800 t of copper cathode, mostly from Chile (85%) and Peru (13%) in 2002 (Departamento Nacional de Produção Mineral, 2003d, p. 54-55; Ferraz, 2003, p. 5).

In 2002, the reserves at Cobre Salobo, which was Brazil's largest copper project, were estimated to be 1,900 Mt at a grade of 0.65% copper and contained 0.96% copper-equivalent associated with, in order of value, gold, silver, and molybdenum. These reserves could support a 250,000-t/yr production capacity of refined copper with byproducts of, in order of added value, gold, silver, and molybdenum. The project, which is in Marabá, Pará, was a joint venture of the Brazilian Banco Nacional de Desenvolvimento Econômico e Social (BNDES) and CVRD; BNDES was the minority member, and CVRD held most of the majority interest (Departamento Nacional de Produção Mineral, 2003d p. 55). A feasibility study on Mineração Maracá S.A.'s Chapada copper project in Alto Horizonte, Goiás, estimated that its ore reserves were 434.5 Mt and contained 1.3 Mt of copper and 9.6 t of gold. Cristalino and Corpo Alemão in Carajás, Pará, were being explored by Mineração Serra do Sossego S.A., which was a joint venture between CVRD and Phelps Dodge Corp.; current resources of copper were estimated to be 400 Mt at a grade of 1.14% copper and 0.34 gram per metric ton gold. The Cobre Sossego project was under construction and was expected to produce 140,000 t of copper and 3 t of gold by 2004. CMSA was planning to produce about 500,000 t/yr of electrolytic copper in D'Ávila, Bahia, by 2010 (Departamento Nacional de Produção Mineral, 2003d, p. 55; Ferraz, 2003, p. 5-6).

Brazil's refined copper production was used primarily in the automobile and construction industries. Exports amounted to 83,200 t of copper metal valued at \$131.5 million, which went to the United States (64%) and Chile and Argentina (18% each) (Departamento Nacional de Produção Mineral, 2003d, p. 54-55).

Gold.—Gold production was reported by the DNPM to be 38 t; mining companies produced 33 t, of which 22 t was the coproduct of imported copper and 5 t, from garimpeiros; the total gold output was 14 t lower than that of 2001 (table 1). CVRD was the largest producer with an output of 10.3 t of gold. AngloGold was second largest gold producer with outputs of about 7 t from Rio Paracatu, almost 6.4 t from Morro Velho, 5.8 t from Serra Grande, and 3.2 t from São Bento (Ferraz, 2003, p. 6). Gold production from the garimpeiros and the private sector decreased because of higher production costs, depletion of the Igarapé Bahia Mine in Carajás and other shallower deposits, and much higher environmental standards. Refined gold from the São Bento Mine was extracted by a combination of pressure oxidation and bioleaching (Biox

process) developed by Gold Fields Ltd. and Mintek Ltd. of South Africa. Mineração Maracá's São Vicente Mine in Mato Grosso produced 1.5 t of gold. Production at the São Vicente Mine will be expanded to about 10 t of gold during 2004 (Departamento Nacional de Produção Mineral, 2003d, p. 100-101).

AngloGold 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 Branca do Amapari in the Amazon region. Desert Sun Mining Corporation (DSM), which was a junior Canadian company, was interested in a joint venture with Jacobina Mineração e Comércio (JMC) of Bahia on the Serra do Córrego gold property, which would require the following capital outlays: \$500,000 in 2002, \$1.5 million in 2003, and \$2 million in 2004. DSM's share would be 51%, and JMC's, 49% (Departamento Nacional de Produção Mineral, 2003d, p. 101).

Iron and Steel.—Ferroalloys.—Ferroalloys production increased to 330,300 t in 2002 from 301,200 t in 2001. This significant increase of almost 9.7% in ferroalloy output was the result of the end of the country's drought that affected the hydroelectric power supply system in 2001. Brazil's Prometal Produtos Metalúrgicos S.A. took Norway's Elkem A/S, which was one of the world's largest manganese alloy producers, as a partner to produce a projected 500,000 t of ferromanganese by 2004; the project, in which Elkem will hold a 40% share, was 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. (a joint venture among CVRD, 49%; Mitsubishi Corp., 25.5%; and Kawasaki Steel Corp., 25.5%) was building a silicon ferroalloy plant with an installed capacity of 48,000 t/yr in Nova Era, Minas Gerais. About two-thirds of its output will be exported mainly to Japan during 2002 and 2010 (Departamento Nacional de Produção Mineral, 2003d, p. 72).

Iron Ore.—Brazil produced 212 Mt of beneficiated iron ore compared with 210 Mt in 2001. About 94.4% of that production was from the major iron ore companies—CVRD, Minerações Brasileiras Reunidas S/A (MBR) (equally owned by CVRD and Mitsui Co. Ltd. of Japan), Ferteço Mineração S.A., S.A. Mineração da Trindade (SAMITRI), Samarco Mineração S.A., CSN, and V & M Mineração Ltda. In 2002, Brazil exported 131.8 Mt of iron ore and 122.5 Mt of pellets valued at \$2.0 billion and \$1.0 billion, respectively (Departamento Nacional de Produção Mineral, 2003d, p. 71; Ferraz, 2003, p. 7).

The total iron ore exports were 6.9% higher than those of 2001 and were shipped to 40 countries worldwide. Total export revenues increased by almost 4% from \$2.9 billion in 2001. The major importers of Brazilian iron ore were Japan (17%), China (16%), Germany (13%), Italy (6%), and France (5%). The customized commercial products (varied chemical characteristics) sold were sinter feed and pellet feed (69.3%), pellets (21.7%), and lump ore (9%) (Departamento Nacional de Produção Mineral, 2003d, p. 71).

CVRD and Pohang Iron and Steel Co. of the Republic of Korea invested \$220 million to produce 4 Mt/yr of pellets. The facility was in the port of Tubarão, Espírito Santo. CVRD was planning a new \$400 million pelletizing plant with railroad and

port facilities in São Luiz, Maranhão. MBR opened three new mines—Capão Xavier, Capitão do Mato, and Tamandua—in 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 after 40 years of operation. Mineração Corumbaense S.A. (a subsidiary of Rio Tinto) 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 Bolivia and Brazil that connects the Santa Cruz de la Sierra, Bolivia, to Campinas, State of São Paulo (Departamento Nacional de Produção Mineral, 2003d, p. 71).

From 2000 through 2002, CVRD acquired the following Brazilian enterprises: SOCOIMEX (100%), which had the capacity to produce 7 Mt/yr of iron ore, for \$48 million; SAMITRI (51%) for \$711 million; and Gulf Industrial Company (50%), which was the owner of a pellet plant in Bahrain with a 4 Mt/yr capacity, \$92 million. On December 7, 2001, CVRD completed the acquisition of Caemi Mineração e Metalurgia S.A. (Caemi) (50%) for \$279 million. Caemi was a nonoperational holding firm and controlled 85% of MBR, which was Brazil's second largest producer of iron ore with a capacity to produce 31 Mt/yr. In 2002, CVRD started up its 12th iron ore pellet in the port of Ponta de Madeira, State of Maranhão, with a capacity to produce 6 Mt/yr. CVRD was planning to invest about \$6 billion to focus in the mining sector by 2007 and to consolidate its leading position in the global iron-ore market (Mining Journal, 2002b, c; Ferraz, 2003, p. 7).

Pig Iron.—Brazil produced 29.7 Mt of pig iron, which was about 8.4% higher than that of 2001. The 4.4 Mt of exports, which was valued at \$473 million, was approximately one-third of the pig iron traded in the world (Departamento Nacional de Produção Mineral, 2003d, p. 72).

Steel.—For the year, raw steel production amounted to 29.6 Mt, which represented an increase of 10.9% compared with that of 2001. Brazil was the fifth largest producer and eight largest exporter of steel worldwide (Fenton, 2003; Departamento Nacional de Produção Mineral, 2003d, p. 72-73). Apparent domestic consumption of steel was about 18.7 Mt, or about the same level as that of 2001. The major recipients of Brazil's exports were Asia, 5 Mt; Latin America, 2 Mt; and the United States, 1.4 Mt. The Instituto Brasileiro de Siderurgia (IBS) stressed that the Brazilian steel industry needed to become more efficient because privatization had improved efficiency and reduced employment levels of the Brazilian steel industry. The IBS believed that vertical integration was evident as customers and suppliers of the steel companies participated in company auctions (Instituto Brasileiro de Siderurgia, 2002, p. 32). CVRD and Nucor Corp. signed a nonbinding memorandum of cooperation to advance their own interests in potential iron and steel business opportunities in the Americas, which may exist as a result of the restructuring of the North American steel industry (Ferraz, 2003, p. 7).

Manganese.—In 2002, Brazil produced 2.5 Mt of manganese ore, which was about 35.7% higher than that of 2001. CVRD's high-grade manganese mine Igarapé Azul in the Carajás Complex accounted for 70% of metallurgical manganese production, which was about 24.8% higher than that of 2001

(1.6 Mt). Construtora Polares Ltda., which was a medium producer, and small producers (in order of importance, in the States of Minas Gerais, Goiás, and Bahia), produced 177,000 t of manganese ore, which was 0.6% higher than that of 2001. Exports of manganese ore accounted for 903,000 t valued at \$41.4 million; this was a decrease of almost 25%, which was due to a higher demand for steel in Brazil and by Mercosur. Manganese ferroalloys exports increased by about 19.5%, which amounted to 147,000 t valued at \$63.2 million (Departamento Nacional de Produção Mineral, 2003d, p. 89).

Nickel.—Brazil produced about 3.9 Mt of nickel ore, which was about the same level as that of 2001. Production of electrolytic nickel, nickel in ferronickel alloys, and nickel in matte decreased to 29,950 t from 32,624 t in 2001. Mineração Serra da Fortaleza, which was located in Fortaleza de Minas, State of Minas Gerais and was owned by Rio Tinto, produced 6,274 t of nickel contained in matte, which was 38.8% lower than that of the previous year. Companhia Niquel Tocantins of Grupo Votorantin (GV) in Niquelândia, State of Goiás, produced 18,100 t of nickel contained in carbonates obtained by ammoniacal leaching a hydrometallurgical process, which was about 6.1% higher than that of 2001; and also in the same district, CODEMIN S.A. of Anglo American produced 6,011 t of nickel contained in ferronickel alloy, which was 4.2% higher than that of 2001 (Departamento Nacional de Produção Mineral, 2003d, p. 99; Ferraz, 2003, p. 7-8).

Owing to the increase in world demand for stainless steel and improved nickel prices, investments of \$1.4 billion in the Brazilian nickel industry were planned to increase the production capacity to 107,000 t/yr by 2004 from 34,000 t/yr in 2002. CVRD intended to invest \$600 million to produce 40,000 t/yr of nickel metal from its Vermehlo project in Carajás, Pará, which contained reserves of 100 Mt at a grade of 1.5% nickel. Anglo American will develop the Barro Alto nickel project in Goiás by investing \$750 million to produce 40,000 t/yr of nickel from a deposit with 117 Mt grading 1.5% nickel. Companhia Niquel Tocantins will increase production capacity to 20,000 t/yr from 17,000 t/yr at a cost of \$50 million in Niquelândia, Goiás. Falconbridge Limited of Canada, which was world's third largest producer of refined nickel, entered into exploration negotiations with the Brazilian Government for sulfide and lateritic nickel in the country in 2000; thus far, Falconbridge had invested \$500,000 for preliminary research and map collection with CPRM and DNPM (Departamento Nacional de Produção Mineral, 2003c, p. 81-82).

Tin.—Brazil was the world's fifth largest tin producer after China, Peru, Indonesia, and Bolivia (Carlin, 2003). Tin production was 12,000 t of tin contained in concentrate and 11,700 t of metal; this was a decrease of almost 4% of tin concentrate compared with that of 2001. During the past 5 years, production cuts were made at the Pitinga Mine in the State of Amazonas, which was operated by Marmoré S.A. and owned by GP, and at the garimpeiros' Bom Futuro operations in Rondônia; Amazonas (72%) and Rondônia (25%) continued to be the major producers in the country. Marmoré's mine produced 9,600 t compared with 10,000 t in 2001; byproducts were, in order of importance, columbium (niobium), tantalum,

zirconium, hafnium, thorium, and cryolite. Marmoré was planning to develop its Rocha Sa project to increase total tin ore output to 14,300 t/yr by 2004 (Mining Journal, 2002d). Exports increased to 6,042 t valued at \$22.3 million from 6,432 t valued at \$25.9 million in 2001. During the past 5 years, the highest exports were registered in 1997 (11,957 t valued at \$62.5 million). The Association of Tin Producing Countries fell below the quota of 20,185 t/yr that had been assigned for these exports to Brazil. Manufactured goods were shipped to Argentina (83%) and semimanufactured goods to the United States (82%) (Departamento Nacional de Produção Mineral, 2003d, p. 66-67; Ferraz, 2003, p. 8).

Zinc.—Brazil produced 136,430 t of zinc content in concentrates, which was about 22.4% higher than that of 2001. GV's Companhia Mineira de Metais S.A. (CMM), which was the only producer of zinc ore in Brazil, produced 106,107 t of zinc silicate in Vazante, which was about 46.4% higher than that of 2001, and 30,232 t of zinc sulfide concentrates in Paracatu, which was about 8.7% higher than that of 2001 (Departamento Nacional de Produção Mineral, 2003d, p. 128-129). The concentrates were processed in CMM's plant in Três Marias and GP's Juiz de Fora Complex in Minas Gerais. These zinc refineries produced 249,434 t of primary metal, which was about 26.6% higher than that of 2001. CMM produced 156,570 t (62.8% of the total), which was an increase of 31.9% compared with that of 2001, and GP's Companhia Paraibuna de Metais S.A. produced 92,866 t (37.2% of the total), which was an increase of 18.5% compared with that of 2001 (Departamento Nacional de Produção Mineral, 2003d, p. 128; Ferraz, 2003, p. 8).

To meet Brazil's demand for zinc, which was approximately 209,570 t/yr of metal, the country imported 236,740 t of zinc concentrates (valued at \$51.2 million), which was 28.8% higher than that of 2001 (183,792 t valued at \$52.4 million), and 19,828 t of metal, which was 47.7% lower than that of 2001. Peru supplied 91% of the concentrates and 61% of the metal; additional needed zinc metal was supplied by Argentina (32%) and the United States (7%) (Departamento Nacional de Produção Mineral, 2003d, p. 128; Ferraz, 2003, p. 8).

To expand the Três Marias zinc refinery to 160,000 t/yr by 2004 from 110,000 t/yr in 2002 and to identify additional zinc reserves in Paracatu, CMM invested \$100 million and \$8 million, respectively, in 2002. CMM was planning to expand it further to 240,000 t/yr by 2004. On March 27, 2002, Grupo Votorantin acquired Cia. Paraibuna de Metais for \$66 million and became the only zinc producer in the country (Departamento Nacional de Produção Mineral, 2003d, p. 129; Ferraz, 2003, p. 8).

Industrial Minerals

Asbestos.—Brazil's significant asbestos deposits were in Cana Brava, Minaçu, Goiás; Goiás was the only producing State in the country. Sociedade Anônima Mineração de Amianto produced 194,730 t of asbestos fiber, which was about 12.8% higher than that of 2001. Almost 94.6% of Brazil's asbestos production was consumed in, in order of importance, 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, in order of importance, thermal insulators, paper and cardboard, slabs, decorations, insecticide, asphalt for highways and airport runways, and the automobile industry (Departamento Nacional de Produção Mineral, 2003d, p. 56-57).

Brazil exported about 46.4% of its production mainly to Thailand (28%), India (21%), Mexico (12%), Indonesia (9%), and Colombia (7%). These exports were 84.2% higher than those of 2001. 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. In contrast, the world's developing economies were expected to increase their collective asbestos consumption by large margins. Brazilian asbestos reserves (16 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 5.245%, and its reserves (fiber content only) were 3 Mt, which, at a production rate of about 200,000 t/yr, represented a 15-year mine life (Departamento Nacional de Produção Mineral, 2003d, p. 56-57).

Cement.—The country produced 38 Mt of cement, which was about 2.3% lower than that of 2001. Among the 22 State producers, Minas Gerais was the most important with 22.3% of the total followed by São Paulo (17.3%), Paraná (10.9%), Rio de Janeiro (7.1%), Brasília (5.1%), Rio Grande do Sul (4.6%), Sergipe (4.5%), Paraíba (4.1%), Ceará (3.9%), Espírito Santo (3.5%), and other States (16.7%). The main producers were GV's Companhia Cimento Portland Itau (41.5%), Grupo João Santos (12.4%), Companhia Cimento Portland Rio Branco (9.9%), Grupo Swiss Holderbank's Holder Cimento S.A. (8.7%), Camargo Correia Cimentos S.A. (8.0%), Grupo Lafarge's Companhia Cimento Portland Paraíso (7.0%), and others (12.5%). Most of the exported cement (294,770 t) went to Paraguay (34%), Bolivia (27%), the United States (19%), Argentina (2%), and other countries (18%). Brazil imported 420,500 t of cement mainly from Venezuela (30%), the United States (23%), Spain (11%), Cuba and Thailand (10% each), Argentina (2%), and other countries (16%). Camargo Correia Cimentos was investing \$200 million to build a new 1.6-Mt/yr cement plant in Ijaci, Minas Gerais, that will began operations by 2003. Grupo Cimentos Portland S/A (CIMPOR) will invest \$180 million to build two cement plants in the State of Paraíba. CIMPOR will produce 1.7 Mt/yr of cement by 2003 (Departamento Nacional de Produção Mineral, 2003d, p. 52-53).

Clays.—Brazil had 4,050 Mt of kaolin reserves, or about 28.5% of the world's total. Production of beneficiated kaolin was about 1.7 Mt, which was about 6.0% lower than that of 2001. The beneficiated kaolin was either coating or filler kaolin. In 2002, Caulim da Amazônia S.A. (CADAM) of Pará accounted for 44.3% of the country's total output; Ymerys Rio Campin Caulim S.A. (RCCSA), 31.5%; Pará Pigmentos S.A. (PPSA), 20.6%; and the remainder was produced by small producers in the States of Minas Gerais, Rio Grande do Sul, and São Paulo, 3.6%. Brazilian kaolin exports were about the

same level as those of 2001, or about 1.4 Mt valued at \$162 million. Shipments were made to Belgium (35%), Japan (16%), the United States (12%), the Netherlands (10%), Finland (7%), and other countries (20%). CADAM increased production of coating kaolin to 800,000 t in 2002 and was expected to increase to 1 Mt/yr by 2005 with an investment of \$30 million. Depending on market conditions, RCCSA was planning to expand its capacity to 850,000 t/yr by 2003 at a cost of about \$15.4 million. PPSA initiated expansions that would increase its capacity to 600,000 t/yr at a cost of \$22.5 million. In Brazil, kaolin consumption decreased by about 30.8% to 269,377 t from 385,720 t in 2001. Kaolin was used mainly in the ceramics and paper industries and, to a lesser degree, in the manufacture of, for example, animal feed, fertilizers, food supplements and pharmaceuticals, paint, pesticides, plastics, and rubber (Departamento Nacional de Produção Mineral, 2003d, p. 48-49).

Fluorspar.—Production of beneficiated fluorspar totaled 47,900 t, which was about 9.5% higher than that of 2001 (43,734 t). The beneficiated fluorspar was either acid or metallurgical grades. Crude ore [run-of-mine (ROM)] production was 131,975 t, which was 6.4% higher than that of 2001. The decline of ROM production during the previous 3 years was due to the shutdown of Mineração Nossa Senhora do Carmo Ltda.'s (MNSCL) Fumaça and Pedras Grandes fluorspar mines. ROM production, by mine, in Santa Catarina was Morro de Fumaça (42.5%), Santa Rosa de Lima (32.8%), Rio Fortuna (9.8%), and in Rio de Janeiro, Tanguá (14.9%). MNSCL was planning to acquire Mineração Del Rey Ltda.'s Cerro Azul Mine in Paraná to start production and to increase domestic production in 2004 (Departamento Nacional de Produção Mineral, 2003d, p. 74-75).

Gemstones.—Brazil continued to be one of the world's largest gemstone producers and exporters. Many different varieties of gemstones are found throughout the country; these include, in order of importance, emerald, aquamarine, diamond, amethyst, citrine, chrysoberyl, opal, topaz, agate, and tourmaline. Brazil is the world's only source of some quality gemstones, such as imperial topaz and Paraíba tourmaline (Oliveira, 2003).

In 2002, the mining of gemstones continued to be dominated by the garimpeiros. Brazilian production of gems totaled 1.1 million carats, which was mainly derived from digging activities (garimpos), which amounted to 460,000 carats, or 92% of the total; the private sector produced 40,000 carats, or 8% of the total (table 1). Garimpeiros' production, however, continued to decline because depleting garimpos' reserves and environmental restrictions were increasing. By the end of 2002, some high-content gem placers in indigenous reserves were closed by the Government to exploration, the jewelry industry's gemstone consumption was unknown, taxation on domestic sales of jewelry was high, and the private sector faced severe competition from its black-market counterparts. Taking into consideration these factors, Brazil's gemstone reserves were almost impossible to quantify. Brazil, however, may have great potential because the country has 600 million cubic meters of sedimentary rocks that contain diamond that grade between 0.01 and 0.1 carat per cubic meter, or 15 million carats; this

represented about 1.2% of the world's diamond reserve base (Departamento Nacional de Produção Mineral, 2003d, p. 60-61; Olson, 2003, p. 70-71). The total value of gemstone production was \$48 million. Diamond production decreased to 500,000 carats in 2002 from 700,000 carats in 2001 (table 1).

Total exports of uncut gemstones was about \$33 million, which was lower than the \$34.6 million in 1997. The major markets for uncut stones were Belgium (70%) and the United States (17%), and those for cut stones, the United States (40%), Chile (11%), and Argentina (7%). Imports decreased to \$20.3 million from \$20.6 million in 2001. The main sources of uncut stones were Ireland (60%), the United States (32%), the United Kingdom (3%), and Germany (2%), and those of cut stones, China (24%), Italy (23%), Japan (11%), the United States (10%), and Austria (8%). Brazil had lapidarian centers, many of which have closed owing to the preference of foreign buyers for uncut stones (Departamento Nacional de Produção Mineral, 2003d, p. 60).

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 Pedra Azul, which had a production capacity of 30,000 t/yr; Itapecerica, 11,000 t/yr; and Salto da Divisa, 6,000 t/yr. Production amounted to 61,000 t with 14% carbon content; this was about 12.8% lower than that of 2001. This production was mainly of products that ranged in grade from 65.5% to 99.9% carbon at NGL's plants—Pedra Azul (30,000 t/yr), Itapecerica (10,800 t/yr), and Salto da Divisa (6,000 t/yr). Also in the State of Minas Gerais, Grafita MG Ltda. produced about 12,786 t of natural graphite, which was 10.5% higher than that of 2001, and was consumed domestically after simple grinding. In November 2002, GP's Mamoré Mineração e Metalurgia Ltda. in Maiquinique, Bahia, was sold to Extrativa Metalquímica S/A of Minas Gerais (Departamento Nacional de Produção Mineral, 2003d, p. 82-83).

Three types of beneficiated graphite products (fines, lump, and medium grained) were processed by NGL in Itapecerica and Pedra Azul. Brazil's demand for natural flake-type crystalline graphite was met by the the Itapecerica, Pedra Azul, and the Salto da Divisa beneficiation plants. Exports amounted to 12,778 t valued at \$11.8 million in 2002 compared with 12,788 t valued at about \$13.4 million in 2001. Growth of the domestic consumption of natural graphite during the 1990s was correlated with that of the iron and steel industries, which absorbed about 80% of the natural graphite consumed in Brazil; demand in 2002, however, decreased by about 14.8% to 49,010 t compared with that of 2001. Other uses included battery manufacturing (6.5%), refractories (6%), paint and varnishes (2%), and other miscellaneous uses (5.5%) (Departamento Nacional de Produção Mineral, 2003d, p. 82-83).

Magnesite.—The most important magnesite mine in Brazil was the Pedra Preta Mine, which was owned and operated by Magnesita S.A. (MSA); the mine is located in the Éguas Mountain region of Brumado, Bahia, about 610 km from Salvador. Brazil produced 269,200 t of beneficiated magnesite, which was about 1.3% higher than that of 2001; MSA produced 98%, or 263,840 t. Exports of processed magnesite totaled

72,000 t at a value of \$9.6 million and were shipped mostly to Poland (26%), Paraguay (22%), Argentina (17%), Chile (11%), and Germany (9%). Imports of processed magnesite totaled 7,440 t at a value of \$4.3 million and were imported mostly from Canada (54%), China (11%), the United States (10%), and Mexico and Israel (8% each). By yearend, about 630 Mt of resources with 180 Mt of magnesium content had been identified (Departamento Nacional de Produção Mineral, 2003d, p. 86-87).

Phosphate Rock.—Production of phosphate rock concentrate amounted to about 4.9 Mt, which was about the same level as that of 2001. Production was highly concentrated (94%, or 4.6 Mt) in four mining companies—Fosfertil S.A. (Grupo Fertifós), 34%; Fertilizantes Serrana S.A. (Bunge International Group), 30%; and Copebras S.A. (Anglo American plc.) and Ultrafertil (Grupo Fertifós), 15% each. Anglo American controlled Copebras (100%). Fosfertil and Ultrafertil were controlled by Grupo Fertifós (81.54%) and CVRD (10.96%). Bunge Group controlled Fertifós (100%), Fertilizantes Serrana S.A. (52%), Cargill S.A. (33%), and Fertibrás S.A. (13%) (Ferraz, 2003, p. 9). The reported domestic consumption of concentrates was about 5.9 Mt/yr; this was an increase of 2.3% compared with that of 2001. Of the total phosphoric acid, 73% was used in the fertilizer industry; 25%, in the chemical industry, and 2%, for other uses; these usages remained almost unchanged from those of 2001. Brazil's demand for fertilizers increased to a record of 19.1 Mt in 2002, or 12% higher compared with that of 2001. Domestic production of fertilizers increased to 8.25 Mt from 7.54 Mt in 2001, but Brazil continued its dependency on imports. Imports of concentrates, phosphoric acid, and intermediate products were valued at \$557.4 million compared with those of 2001 (\$593.1 million) (Departamento Nacional de Produção Mineral, 2003d, p. 76-77; Ferraz, 2003, p. 9).

Quartz.—Brazil produced 4,300 t of quartz, which was about the same level as that of 2001. Quartz was exported mostly to Spain (20%), Hong Kong (18%), Canada (11%), and Portugal (10%). Quartz powder was shipped to Germany (67%), the United Kingdom (18%), and the United States (11%). Telequartzo Exportação S.A. and others produced quartz powder, which is an important constituent in the production of, in order of importance, 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, 2003d, p. 108-109).

Salt.—The reported domestic production of salt was 6.1 Mt, which was about 9.5% higher than that of 2001. Rio Grande do Norte continued to be the major producer of marine salt with 96.8% followed by Rio de Janeiro (1.7%) and Ceará (0.5%). The domestic consumption of salt was 5.6 Mt. Brazil also produced 1.3 Mt of rock salt. Salgema Mineração e Química S.A. in Maceió, Alagoas, produced 676,000 t (52%) of rock salt, and Dow Química do Nordeste Ltd. (a subsidiary of Dow Chemical Co. of the United States) produced 624,000 t (48%) of salt from the Vera Cruz Mine in Bahia (Departamento Nacional de Produção Mineral, 2003d, p. 112-113).

In 2002, salt imports increased to 220,000 t from 110,000 t in 2001, or 100%. Imports were sea salt (3,000 t) and bulk, without aggregates, in order of importance, table salt, sodium chloride, and pure sodium (217,000 t). Imports came from Chile (99%) and other countries (1%). Salt exports amounted to 694,000 t, which was a decrease of almost 10% from that of 2001. Exports were sea salt (687,000 t), table salt (4,000 t), and bulk without aggregates (3,000 t). Exports were shipped to Nigeria (59%), the United States (29%), Venezuela (5%), Belgium (4%), and Uruguay (3%). Salt was consumed by the chemical industry (chlorine and sodium manufacture) (85.4%) and others (caustic soda) (14.6%) (Departamento Nacional de Produção Mineral, 2003d, p. 112-113).

Other Industrial Minerals.—Potassium production increased by about 5.4% to 627,310 t compared with that of 2001. Brazil imported 2.6 Mt of potash mainly from Russia (29%), Canada (25%), Germany (20%), and Israel (18%) (Departamento Nacional de Produção Mineral, 2003d, p. 104-105).

Production of gypsum was more than 1.6 Mt, which was about 8.4% higher than that of 2001. In Brazil, renewed housing and infrastructure construction activities increased the consumption of cement and plasters (Departamento Nacional de Produção Mineral, 2003d, p. 80-81).

Production of talc was 390,000 t, which was about 30% higher than that of 2001. Bahia was Brazil's major talc producer with 53% of the national output followed by Paraná (23%), São Paulo (20%), Rio Grande do Sul (3.0%), and Minas Gerais (1%) (Departamento Nacional de Produção Mineral, 2002d, p. 114-115).

Mineral Fuels

Brazil produced 16.1 billion cubic meters of natural gas and 560.3 million barrels of petroleum, which were 15.0% and 14.9% higher, respectively, compared with those of 2001. The country produced, in order of importance, crude oil, natural gas liquid, natural gas, and shale oil; production totaled 660.7 million barrels of oil equivalent (Departamento Nacional de Produção Mineral, 2003d, p. 78-79; 102-103; *Petróleo Brasileiro S.A.*, 2003, p. 2). In 2002, Petrobrás's average production of crude oil, which included condensate and natural gas liquid, was about 1.812 million barrels per day (Mbbbl/d), which was 10.7% higher than that of 2001 and which was a new production record as of December 31, 2002 (*Petróleo Brasileiro S.A.*, 2003, p. 2-4, 11-12).

Petrobrás was planning to increase its daily output rate to 1.9 Mbbbl by 2005 and to produce about 75% of this output from deepwater. The cost of oil produced was \$3.00 per barrel of oil equivalent compared with that of \$3.26 in 2001. In 2002, the supply of natural gas totaled about 36.1 million cubic meters of which 10.5 million cubic meters was imported from Bolivia compared with 6.2 million cubic meters in 2001, and of that total, 24.8 million cubic meters was consumed in Brazil, and the remainder was used by Petrobrás (Ferraz, 2003, p. 10).

Coal.—The Brazilian coal industry's mine operations were concentrated in the three southernmost States—Santa Catarina

(61%), Rio Grande do Sul (38%), and Paraná (1%). In 2002, Brazilian energy-generation-type coal (marketable output) production was about the same level as that of 2001 (6 Mt) (table 1; Departamento Nacional de Produção Mineral, 2003d, p. 46).

The main producers of ROM coal were Copelmi Mineração Ltda. with 2.0 Mt followed by Companhia Riograndense de Mineração S.A. (CRM) (1.7 Mt), Companhia Carbonífera Metropolitana S.A. (1.2 Mt), and Carbonífera Circiúma S.A. (1.1 Mt). Coal demand increased mainly because the thermoelectric plants were operating at full capacity in these three States. In 2002, domestic coal sales reached 5.8 Mt, of which Santa Catarina used 51.9%, Rio Grande do Sul, 47.8%, and Paraná, 1.3%. To meet Brazil's metallurgical coal demand, 13 Mt at a value of \$633 million was imported; this was a decrease of 12% compared with that of 2001. Imports came from the United States (30.3%), Australia (24.5%), China (15.6%), Canada (9.2%), South Africa (4.7%), and other countries (15.7%) (Ferraz, 2003, p. 5). Brazil imported 1.6 Mt of mineral coal coke as well, which was an increase of 78% compared with that of 2001; China was the main supplier. Total coal consumption reached 17.1 Mt, which was about the same as that of 2001. The steel industry consumed 64.7% of metallurgical-grade coal; thermoelectric generation, 33%; and the petrochemical and pulp and paper industries, 2.3% (Departamento Nacional de Produção Mineral, 2003d, p. 47). Brazil was planning a priority thermoelectric generating program based mostly on natural gas and coal and that would involve 49 new power stations based mainly on natural gas. The three plants to be built in Rio Grande do Sul will be coal fired. These new powerplants were part of the Government's 17-gigawatt emergency plan (supplied largely by *Electrobrás S.A.*) to cope with the increased demand of electricity. Circiúma and Metropolitana were negotiating with *Usina Termoelétrica do Sul Catarinense* to supply coal to produce 400 megawatts (MW). Most Brazilian coals have a lower content of carbon and a higher content of ash compared with the Colombian coals in the Guajira area. Total Brazilian coal reserves were estimated to be 930 Mt (Departamento Nacional de Produção Mineral, 2003d, p. 46-47; Ferraz, 2003, p. 4-5).

Natural Gas and Petroleum.—Brazil produced 44 million cubic meters per day of gas in 2002, which was 14.3% higher than that of 2001. The gas pipeline that links the Enchova platform in the offshore Campos Basin to Macaé, Rio de Janeiro, added 5 million cubic meters per day of gas flow to the Rio de Janeiro and the São Paulo markets; offshore gas production accounted for 56.8% of the total. Petrobrás signed 2 agreements with *Yacimientos Petroleros Fiscales de Argentina* and with *Yacimientos Petroleros Fiscales de Bolivia* to supply natural gas to Brazil. The Argentina-Brazil gas pipeline linked *Aldeia Brasileira* in Argentina to Porto Alegre in Rio Grande do Sul. The \$2 billion 3,150-km Bolivia to-Brazil gas pipeline started operation and will increase the supply of natural gas along the 1,970 km of pipeline between Santa Cruz de la Sierra, Bolivia, and Porto Alegre, Brazil, to supply Mato Grosso do Sul, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul with 10.5 million cubic meters per day in 2002 and into 2005, 16 million cubic meters per day from 2005, and 30 million cubic meters per day from 2010. The natural gas share of the

country's energy mix was 3% in 2002 and will be 12% in 2010. Petrobrás continued producing natural gas in the Gulf of Mexico and recovered gas from the Frederick Field, which is located 27 km off the Louisiana coast (Departamento Nacional de Produção Mineral, 2003d, p. 78-79, 102; Ferraz, 2003, p. 9-10; Petróleo Brasileiro S.A., 2003, p. 46).

In 2002, the total international production of oil and liquefied natural gas amounted to 35,200 barrels per day, and natural gas output was almost 4 million cubic meters per day, which totalled 58,100 barrels of oil equivalent per day. Exploration and production took place in Angola, Argentina, Bolivia, Colombia, Equatorial Guinea, Nigeria, Trinidad and Tobago, and the United States. As a result of the acquisition of Perez Companc in 2002, Petrobrás will start exploration and production in Ecuador, Peru, and Venezuela by 2004 (Petróleo Brasileiro S.A., 2003, p. 52).

Brazil produced 1.5 Mbbbl/d of petroleum, which was 15.4% higher than that of 2001. Imports of crude oil and derivatives were valued at \$3.5 billion compared with almost \$4 billion in 2001. The main sources were Nigeria (27.0%), Algeria (22.3%), Saudi Arabia (17.3%), Iraq (10.3%), Argentina (9.3%), and other countries (13.8%) (Departamento Nacional de Produção Mineral, 2003d, p. 103; Petróleo Brasileiro S.A., 2003, p. 52).

Uranium.—Brazil owned the fifth largest uranium reserves in the world (Raposo dos Santos, 2001, p. 389). The country's indicated reserves amounted to 21.9 Mt of uranium oxide (U_3O_8) and 67 Mt of inferred reserves; minable reserves contained more than 103,200 t at a grade of 0.104% U_3O_8 . Private interests were permitted to participate in uranium operations in Brazil through state-owned joint ventures; no more than 20% of the country's uranium reserves may be exported (Departamento Nacional de Produção Mineral, 2001, p. 35, 389-391).

Reserves

Brazil was among the world leaders in reserves of some mineral commodities. According to the Departamento Nacional de Produção Mineral (2003d, p. 11), the commodities were ranked as follows: first, columbium (niobium) and tantalum; second, graphite and tin; third, aluminum, kaolin, talc, and vermiculite; fourth, magnesite and manganese; and fifth, iron ore (table 3).

Infrastructure

Brazil's railroads comprised a total of 31,543 km (1,981 km electrified), of which 4,961 km was 1.600-m gauge (692 km electrified), 194 km was 1.440-m gauge (630 km electrified), and 25,992 km was 1.000-m gauge (581 km electrified). In addition, three rails had dual gauge—396 km of 1.000- and 1.600-m gauge (78 km electrified). The country had a total of almost 2 million kilometers (Mkm) of roads—184,140 km was paved, and 1.8 Mkm was gravel and dirt. Brazil had 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—82 were bulk vessels; 56, tankers; 15, chemical tankers; 14, combination ore

and oil vessels; 10, liquefied gas tankers; and 2, combination bulk vessels. Brazil had 3,590 airports of which 665 were paved and 2,925 unpaved (Vale, 2003, p. 18-23; U.S. Central Intelligence Agency, 2003§).

In 2002, Brazil's installed electrical generating capacity was 52,865 MW. Total production of electric power for the year was 321,200 gigawatthours, which translated into 1,370 kilowatthours per capita. Brazil's primary domestic energy supply encompassed the following: hydroelectric, 82.7%; petroleum and natural gas, 8.3%; nuclear energy, 4.4%; and others, 4.6% (Vale, 2003, p. 18-23; U.S. Central Intelligence Agency, 2003§).

The Bolivia-Brazil pipeline, which was owned by a consortium of the Royal Dutch/Shell Group, Enron, and Petrobrás, was the largest of the various cross-border energy projects. Argentina supplied gas to Rio Grande do Sul's new thermoelectric plant, 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. The total pipeline network was 15,772 km of which 7,920 km consisted of crude oil and petroleum products, and 5,252 km, of gas, which excluded the Brazilian side (2,600 km) of the Bolivia-Brazil gas pipeline. 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 globalization, liberalization, and privatization. State-owned corporations entered into partnerships with private domestic and foreign investors (Chodorowski and Carnecir, 2002; Petróleo Brasileiro S.A., 2003, p. 37).

Negotiations were completed between the Brazilian Government and five companies in 2001, four of which were foreign subsidiaries. The companies involved were Alcan, Alcoa, Billiton, Camargo Corrêa Industrial S.A. (Brazil), and Dow Chemical, USA. Brazil and the five companies will build a 1,200-MW dam, which will be named Tucuruí, on the Tocantins River on the border between Maranhão and Tocantins. Construction of the dam was estimated to cost about \$1 billion; Billiton pledged \$350 million (Vale, 2003, p. 23). This new dam appeared to be necessary because demand for hydroelectricity was growing at a rate faster than that of supply as a result of the aftermath of the severe drought in 2001. The supply of subsidized electricity in the Tocantins area was exceeded by the mining and industrial activities in 2002. The 10% electrical subsidy was expected to be phased out by 2004 (Vale, 2003 p. 20). Alcoa acquired ownership of one concession as part of a consortium, and Alcan obtained the right to build three separate hydroelectric power stations (Mining Journal, 2002a). The aluminum companies won the right to build new hydroelectric plants in the auction of the National Agency of Electric Power (Aneel). They secured eight concessions that will demand a total investment of more than \$1 billion. In the auction of Aneel, Alcan secured the right to build hydroelectric plants at Barra dos Coqueiros and Caçu in the State of Goiás and Traira II in the State of Minas Gerais. Alcan planned to invest \$180 million in their construction. Alcan paid \$1.3 million per year for the concession of the 60-MW Traira I plant (Ferraz, 2003, p. 3-4).

Constran S.A. and Construção e Comércio of Grupo Itamaraty 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 that runs through Vitória, Espírito Santo; Belo Horizonte, Minas Gerais; Santos, São Paulo; and Chapadao do Sul, Mato Grosso do Sul. This new railroad system will run from Chapadao do Sul to Cuiabá, Mato Grosso and Santarem, Pará, branching from Cuiabá to Porto Velho, Rondônia (Vale, 2003, p. 22).

Outlook

Brazil will continue to be a strong economy in Latin America and one of the world's most important minerals producer of, in order of importance, metals, industrial minerals, and fuel minerals. Future hydroelectric and thermoelectric powerplants coming onstream should ease Brazil's recovery from its energy crisis in 2001. The new Government's election resulted in a weakening of the real, as investors feared the impact of its new social program in education, health, and public security (Mining Journal, 2002a). The domestic front was dominated by the uncertainty of the presidential election in the last quarter of 2002, and internationally, the Brazilian economy was affected by the slow growth of the G8 Summit economies, in order of magnitude, the United States, Japan, United Kingdom, Germany, France, Italy, Russia, and Canada; the Wall Street scandals; and the political upheaval in the Middle East. After the new administration introduced fiscal austerity policies by giving priority to such reforms as the country's complex tax code, trimming the civil service pension system, and continuing the fight against inflation, the real recovered in value.

In spite of the international scene, the Argentinean crisis in particular, and the aftermath of the 2001 domestic energy crisis, the Brazilian economy has remained resilient and was able to post a GDP growth of 1.5% in 2002. As an exporter of mineral commodities, the country is poised to benefit from the continued depreciation of the real caused by the financial risks, which, in part, were triggered by the more severe crisis in Argentina. Brazil's share of the region's net FDI inflows decreased to \$16.6 billion in 2002 from \$22.5 billion in 2001, which reflected the uneasiness in the financial markets owing to the aftermath of the Wall Street scandals and the slowdown of the largest economies in the world. Other foreign investors, however, showed confidence in the country, which can support continued economic growth and investments in new technology well into the next decade.

Deferment of major investment decisions was not reported. Even firms that have been financed with borrowed U.S. dollars, which include CVRD, have the hedge provided by their exports. CVRD will invest about \$6 billion in mineral project developments and acquisitions into 2007. The significance of the investment would be to increase CVRD's market capitalization to \$25 billion from its 2001 level of about \$10 billion (Mining Journal, 2002b). The Brazilian economy, however, was affected by the volatility of the international financing market, depressed prices for mineral exports, and the aftermath of the country's power shortage owing to its worst drought in decades (Mining Journal, 2002a).

The various sectors of the Brazilian economy recorded diverse rates of growth in minerals, 3.4%; agriculture, 3.0%;

services, 2.5%; and industrial, 0.6 % (Departamento Nacional de Produção Mineral, 2003a, p. 1; Ferraz, 2003, p. 1; Banco Central do Brasil, 2003c§). If the positive rate of economic growth in the minerals sector is sustained into 2003 and beyond, then it should continue its expansion as the demand for mineral exports and fabricated steel goods increases. Mercosur has undergone dramatic changes in natural gas and power markets owing to the increase in cross-border energy investment opportunities, domestic gas consumption, and internationalization of the energy sector. Brazil has become the center of an increasingly rapid process of energy integration in South America owing to the country's gas market, which is in full evolutionary mode with an unsatisfied energy demand and a great potential for growth.

Investments in the Brazilian mining industry were expected to continue to enhance exploration and mine development activities, particularly in, in order of importance, iron ore, gold, copper, and emeralds. This trend should continue because several corporations were forming consortiums and acquiring exploration properties, mining prospects, and permits particularly for, in order of importance, oil and gas, iron ore, gold, diamond, and base metals.

Brazilian gold production could increase significantly in the foreseeable future because of the growth of Brazilian copper production and of increased interest by domestic and foreign investors in largely unexplored areas. More than 2,000 gold occurrences, which are mostly Precambrian vein deposits and alluvial placers, were known (Departamento Nacional de Produção Mineral, 2003d, p. 101; Ferraz, 2003, p. 6).

After privatization of the steel industry, CVRD, and other sectors of the Brazilian economy, such as energy, services, telecommunications, and transportation, new projects in the oil and gas sectors will continue to be open to mergers and joint-venture projects with domestic and foreign investors; thus, the Brazilian economy is expected to remain sustainable and competitive within a more inclusive globalization and privatization processes in the years to come.

The existing Brazilian infrastructure is of particular interest to the minerals industry and its related industries. Brazil has a good industrial base capable of supplying most of the required mining and oil and gas equipment and modern and reliable transportation and communication systems and can provide skilled labor; modern mining, oil, and new technologies; and an efficient network of supporting services. Improvements and additional infrastructure, however, would have a direct bearing on Brazil's ability to increase metal, industrial minerals, and mineral fuel production competitively. The sectors most likely to be affected will be those that depend most heavily on electricity, telecommunication, and transportation facilities.

The aluminum, the automobile, the petrochemical, the pulp and paper, and steel industries, which depend heavily on energy and exports, will likely benefit most from additional and improved power-generating infrastructure. Of the 52 powerplants to be built in the foreseeable future, 49 will be based mainly on natural gas, and 3, on coal; they would be the major drivers for growth in mineral fuels demand. In January 2002, the Government eliminated all price controls and import tariffs on petroleum and derivatives to motivate private investment and to increase competition that would benefit the

Brazilian economy. Petrobrás was expected to build additional refineries with the participation of new partners from the private sector.

Brazil's dynamic and diverse economy coupled with its sizeable consuming market and its membership in Mercosur will continue to attract the interest of investors of all types and origins. The Amazon region alone was considered to have possibilities for major undiscovered mineral wealth in addition to the large reserves of, in order of value, iron ore, manganese, bauxite, gold, and tin. A factor that may place constraints on mineral development over the longer term was the concern over biodiversity in the Amazon Rainforest, which composes 30% of the world's remaining tropical forests, provides shelter to one-tenth of the globe's plant and animal species, and removes excess carbon dioxide from the atmosphere (U.S. Energy Administration, 2003§). Much will depend on the approaches to be used for economic and social development while protecting the environment in a sustainable way.

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Rua General Severiano
90 Botafogo-ZC-02
22290-Rio de Janeiro-RJ-Brasil
- Companhia de Pesquisa de Recursos Minerais
Avenida Pasteur 404-Anexo, 2º Andar, Pira Vermelha
22290-Rio de Janeiro-RJ-Brasil
- Conselho de Não-Ferrosos e de Siderurgia
Esplanados dos Ministerios-Bloco 6-5º Andar
70053-Brasilia-DF-Brasil
- Conselho Nacional do Petróleo
SGAN-Q.603 Modulos J, I e H
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- Rio Doce Geológica e Mineração, S.A.
Avenida President Wilson 11º Andar
22030-Rio de Janeiro-RJ-Brasil

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Associação Brasileira dos Produtores de Ferroligas (ABRAFE),
Sao Paulo: ABRAFE Yearbook, annual.
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TABLE 1
BRAZIL: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity ²	1998	1999	2000	2001	2002 ^e
METALS					
Aluminum:					
Bauxite, dry basis, gross weight	11,961,000	13,839,000	13,846,000	13,790,000 ^r	13,189,000 ³
Alumina	3,322,000	3,515,000	3,743,000	3,445,000 ^r	3,962,000 ³
Metal:					
Primary	1,208,000	1,249,600	1,277,000 ^r	1,140,000 ^r	1,318,000 ³
Secondary	170,000	190,000	210,000	200,000 ^r	215,000 ³
Beryllium, beryl concentrate, gross weight	5	11	13	13	11 ³
Cadmium, metal, primary ^c	300	300	300	300	300
Chromium:					
Crude ore	554,813	457,851	611,200	420,000	420,000
Concentrate and lump, Cr ₂ O ₃ content	209,596	207,123	253,248 ^r	178,013 ^r	113,811 ³
Marketable product ^d	81,886	103,015	70,040 ^r	38,472 ^r	11,186 ³
Cobalt:					
Mine output, Co content by hydroxide ^e	400	400	900	900	900
Metal, electrolytic ⁵	364	630 ^e	900	900	900
Columbium (niobium)-tantalum ores and concentrates, gross weight:					
Columbite and tantalite ^e	330	330	330	330	330
Djalmaite concentrate ^e	10	10	10	10	10
Pyrochlore concentrate, Nb ₂ O ₅ content	33,795	31,352	31,190	39,039 ^r	41,303 ³
Copper:					
Mine output, Cu content	34,446	31,371	31,786	30,111 ^r	30,642 ³
Metal:					
Primary	167,205	193,014	185,345	212,243 ^r	189,651 ³
Secondary	54,150	54,220	47,500 ^r	36,000 ^r	23,000 ³
Gold:					
Mine output	37,787	42,367	42,025	46,001 ^r	32,886 ³
Garimpeiros (independent miners)	11,780	10,267	8,368	5,866 ^r	5,000 ³
Total	49,567	52,634	50,393	51,867 ^r	37,886 ³
Iron and steel:					
Ore and concentrate, marketable product:⁶					
Gross weight	197,500	194,000	212,576 ^r	210,000 ^r	212,000 ³
Fe content	131,670	128,040	141,106 ^r	139,400 ^r	140,000 ³
Metal:					
Pig iron	25,111	25,060	27,723	27,781 ³	29,600 ³
Ferroalloys, electric-furnace:^e					
Chromium metal	40	40	40	40	40
Ferrocilcium silicon	25,000	25,000	25,000	25,000	25,000
Ferrocromium	72,507 ³	90,784 ³	134,562 ³	84,428 ³	82,100
Ferrocromium silicon	5,000	5,000	5,000	5,000	5,000
Ferrocolumbium	20,516 ³	18,866 ³	18,218 ³	24,864 ^r	24,174 ³
Ferromanganese	122,000	110,000 ³	121,277 ³	96,016 ³	149,000
Ferromolybdenum	50	50	50	50	50
Ferronickel	8,077 ³	6,502 ³	6,347	5,768 ^r	6,011 ³
Ferrophosphorus	2,000	2,000	2,000	2,000	2,000
Ferrosilicon	210,000 ³	210,000 ³	188,735 ³	159,345 ³	159,400
Ferrosilicon magnesium	15,000	15,000	15,000	15,000	15,000
Ferrosilicon zirconium	1,500	1,500	1,500	1,500	1,500

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity ²	1998	1999	2000	2001	2002 ^e	
METALS--Continued						
Iron and steel--Continued:						
Metal--Continued:						
Ferroalloys, electric-furnace--Continued:						
Ferrotitanium	500	500	500	500	500	
Ferrotungsten	25	25	25	25	25	
Ferrovandium	3,000	3,000	3,000	3,000	3,000	
Inoculant	25,000	25,000	25,000	25,000	25,000	
Silicomanganese	124,000	110,000 ³	171,304 ³	180,235 ³	180,200 ³	
Silicon metal	120,000	120,000	166,344 ^{r,3}	112,123 ³	112,100 ³	
Total	754,000	743,000	884,000	734,000	790,100	
Steel, crude, excluding castings	thousand tons	25,800	24,600	27,865 ^r	26,718 ³	29,604 ³
Semimanufactures, flat and nonflat ^e	do.	25,000	25,000	25,000	18,006 ³	17,460 ³
Lead:						
Mine output, Pb content in concentrate	7,567	10,281	8,832	9,754 ^r	9,253 ³	
Metal, secondary	48,000	52,000	50,000	47,000 ³	50,000 ³	
Manganese, metal:						
Primary ^e	6,500	6,500	6,500	6,500	6,500	
Secondary ^e	1,600	1,600	1,600	1,600	1,600	
Manganese ore and concentrate, marketable, gross weight ⁴	1,940,000	1,656,000	2,192,000	2,200,000	2,500,000 ³	
Nickel:						
Mine output, ore	2,603,757	2,990,657	2,790,184	3,923,456 ^r	3,873,474 ³	
Ni content in ore	36,764	41,522	45,317	45,300 ^r	45,300 ³	
Ferronickel, Ni content	8,077	6,502	6,347	5,768 ^r	6,011 ³	
Rare-earth metals, monazite concentrate, gross weight ^e	200	200	200	200	200	
Silver ⁷	kilograms	34,000	42,000	41,000	46,046 ^r	33,000 ³
Tin:						
Mine output, Sn content	14,237	13,202	13,773	14,200	14,200	
Metal:						
Primary	14,600	12,787	13,825	13,800	11,675 ³	
Secondary ^e	250	250	250	250	250	
Titanium concentrates, gross weight:						
Ilmenite	103,000	96,000	123,000	111,113 ^r	174,382 ³	
Rutile	1,800	4,300	3,162	1,791 ^r	2,645 ³	
Tungsten, mine output, W content	--	13	18 ^r	22 ^r	24 ³	
Zinc:						
Mine output, Zn content	87,485	98,590	100,254	111,432 ^r	136,430 ³	
Metal:						
Primary	176,806	187,010	191,777	193,061 ^r	249,434 ³	
Secondary ^e	7,000	7,000	7,000	7,000	7,000	
Zirconium, zircon concentrate, gross weight ⁸	20,132	27,160	29,805	20,553 ^r	20,000 ³	
INDUSTRIAL MINERALS						
Asbestos:						
Crude ore ^e	3,950,000	3,950,000	3,950,000	3,950,000	3,950,000	
Fiber	198,332	188,386	209,332	172,695 ^r	194,732 ³	
Barite:						
Crude	55,977	48,789	55,462	63,882 ^r	63,953 ³	
Beneficiated	46,632	44,906	53,741	54,790 ^r	54,895 ³	
Marketable product ^{e,4}	65,000	65,000	65,000	65,000	65,000	
Calcite ^e	35,000	35,000	35,000	35,000	35,000	
Cement, hydraulic	thousand tons	39,942	40,270	39,208	38,927 ^r	38,027 ³
Clays:						
Bentonite, beneficiated	220,000	274,623	273,975	160,381 ^r	174,909 ³	
Kaolin:						
Crude	3,259,518	3,598,326	3,740,815 ^r	4,146,511 ^r	3,953,455 ³	
Beneficiated	1,373,892	1,516,700	1,639,673 ^r	1,817,419 ^r	1,708,457 ³	
Marketable product ⁴	964,268	1,156,593	1,390,636	1,437,399 ^r	1,444,159 ³	
Diamond: ^e						
Gem	thousand carats	100	900 ³	1,000 ³	700 ^r	500 ³
Industrial	do.	600	600	600	600	600
Total ⁹	do.	700	1,500 ³	1,600 ³	1,300 ^r	1,100

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity ²	1998	1999	2000	2001	2002 ^e
INDUSTRIAL MINERALS--Continued					
Diatomite:					
Crude	14,303	14,601	10,164 ^r	10,010 ^r	8,030 ³
Beneficiated	10,162	7,867	7,201 ^r	6,976 ^r	5,835 ³
Marketable product ^{e, 4}	13,100	13,100	13,100	13,100	13,100
Feldspar:					
Crude	200,000	220,000	227,215 ^r	150,000 ^r	150,000 ³
Marketable product ^{e, 4}					
Feldspar	122,000	122,000	117,715 ^r	75,000 ^r	75,000 ³
Laucite	5,000	5,000	5,000	5,000	5,000
Sodalite, crude	500	500	500	500	500
Total	128,000	128,000	123,215 ^r	80,500 ^r	80,500 ³
Fluorspar:					
Crude ore, run-of-mine (ROM)	220,911	98,000	130,976	124,021 ^r	131,975 ³
Concentrates, marketable product:					
Acid-grade	61,024	38,209	30,131	31,263 ^r	32,774 ³
Metallurgical-grade	11,058	6,717	12,831	12,471 ^r	15,125 ³
Total	72,082	44,926	42,962	43,734 ^r	47,899 ³
Graphite:					
Crude ^e	650,000	650,000	650,000	650,000	650,000
Marketable product:					
Direct-shipping crude ore	10,747	NA	NA	NA	NA
Concentrate	50,622	53,503	71,208	70,091 ^r	60,922
Total	61,369	53,503	71,208	70,091 ^r	60,922
Gypsum and anhydrite, crude	1,631,957	1,527,599 ^r	1,497,790 ^r	1,506,619 ^r	1,633,311 ³
Kyanite: ^e					
Crude	750	750	750	750	750
Marketable product ⁴	600	600	600	600	600
Lime, hydrated and quicklime	6,229	6,137	6,273	6,300	6,500 ³
Lithium, concentrates	9,485	11,122	10,875 ^r	9,084 ^r	12,046 ³
Magnesite:					
Crude	1,109,351	868,604	1,006,654	1,079,207 ^r	1,084,786 ³
Beneficiated	308,300	259,834	279,876	265,749 ^r	269,222 ³
Mica, all grades	4,000	3,000	4,000	4,000	4,000
Nitrogen, N content of ammonia	948,600	948,000 ^e	950,000 ^e	950,000	950,000
Phosphate rock, including apatite:					
Crude: ^e					
Mine product	27,000	27,000	26,300	26,740 ^r	31,494 ³
Of which, sold directly	35	35	35	35	35
Concentrate:					
Gross weight	4,421	4,344	4,725	4,805 ^r	4,883 ³
P ₂ O ₅ content	1,561	1,543	1,687	1,707 ^r	1,738 ³
Pigments, mineral, other, crude ^e	2,000	2,000	2,000	2,000	2,000
Potassium (KCl)	544,200	580,380	654,168 ^r	594,930 ^r	627,310 ³
Potash, marketable (K ₂ O)	326,489	348,231	351,681	318,585 ^r	337,266 ³
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	1,594	1,470	3,651	4,350 ^r	4,300 ³
Salt:					
Marine	5,353	4,528	4,626	4,370 ^r	4,835 ³
Rock	1,484	1,430	1,448	1,208 ^r	1,274 ³

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity ²	1998	1999	2000	2001	2002 ^c
INDUSTRIAL MINERALS--Continued					
Silica (silix) ^e thousand tons	1,600	1,600	1,600	1,600	1,600
Sodium compounds:^e					
Caustic soda	1,050,000	1,050,000	1,050,000	1,050,000	1,050,000
Soda ash, manufactured, barilla	200,000	200,000	200,000	200,000	200,000
Stone, sand and gravel:^e					
Dimension stone:					
Marble, rough-cut cubic meters	200,000	200,000	200,000	200,000	200,000
Slate	50,000	50,000	50,000	50,000	50,000
Crushed and broken stone:					
Basalt cubic meters	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Calcareous shells	450,000	450,000	450,000	450,000	450,000
Dolomite thousand tons	3,500	3,500	3,500	3,500	3,500
Gneiss cubic meters	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000
Granite thousand cubic meters	60,000	60,000	60,000	60,000	60,000
Limestone thousand tons	60,000	60,000	60,000	60,000	60,000
Quartz ¹⁰	250,000	250,000	250,000	250,000	250,000
Quartzite:					
Crude	400,000	400,000	400,000	400,000	400,000
Processed	200,000	200,000	200,000	200,000	200,000
Sand, industrial	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000
Sulfur:					
Frasch	24,582	23,232	23,720	24,468 ^r	22,620 ³
Pyrites	1,137	--	--	--	--
Byproduct:					
Metallurgy	186,806	217,119	217,238	280,079 ^r	284,184 ³
Petroleum	36,973	57,962	81,762	80,125 ^r	77,185 ³
Total	249,498	298,313	322,720	384,672 ^r	383,989 ³
Talc and related materials:					
Talc:					
Crude	289,000	294,000	300,000	370,500 ^r	390,000
Marketable product ^{e,4}	2,000	2,000	2,000	2,000	2,000
Pyrophyllite, crude	161,000	160,000	150,000	189,500 ^r	200,000
Vermiculite:					
Concentrate	24,300	23,400	24,074 ^r	21,464 ^r	22,577 ³
Marketable product ⁴	4,200	3,100	3,100	3,100	3,100
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous:					
Run of mine thousand tons	8,582 ^r	12,340 ^r	14,335 ^r	13,800	13,800 ³
Marketable ⁴ do.	504 ^r	6,013 ^r	6,000 ^r	6,000 ^r	6,000 ³
Coke, metallurgical, all types do.	43	50	50	50	50 ³
Gas, natural, gross million cubic meters	10,412	11,898	13,291	14,000	14,000 ³
Natural gas liquids million 42-gallon barrels	2,654	3,345	3,694	5,860 ³	5,860 ³
Petroleum:					
Crude thousand 42-gallon barrels	365,365	413,121	464,280	487,640 ³	547,135 ³
Refinery products:^{11, 12}					
Liquefied petroleum gas do.	58,288	10,950	13,140	14,112 ³	12,700 ³
Gasoline do.	167,943	128,854	134,722	144,691 ³	130,222 ³
Jet fuel do.	695	533	557	598 ³	538 ³
Kerosene do.	32,668	25,064	26,175	28,112 ³	25,300 ³
Distillate fuel oil do.	258,203	198,106	206,885	222,221 ³	200,000 ³
Lubricants do.	7,277	5,584	5,831	6,315 ³	5,684 ³
Residual fuel oil do.	150,415	115,406	118,698	127,482 ³	114,734 ³
Other do.	123,502	94,758	100,893	108,359 ³	97,523 ³
Refinery fuel and losses do.	--	NA	NA	NA	NA
Total do.	798,991	579,255	606,901	651,890	586,701 ³

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES¹

⁶Estimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. [†]Revised. NA Not available. -- Zero.

¹Table includes data available through October 2003.

²In 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.

³Reported figure.

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

⁵Source: Cobalt Development Institute.

⁶Includes sponge iron as follows, in thousand metric tons: 1998 to 2002--270 (estimated).

⁷Officially 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: 1998--40,000; and 1999 to 2002--50,000.

⁸Includes baddeleyite-caldasite.

⁹Figures represent officially reported output plus official Brazilian estimates of output by nonreporting miners.

¹⁰Apparently includes crude quartz used to produce quartz crystal (listed separately in this table), as well as additional quantities of common quartz.

¹¹Figures represent officially reported production to the United Nations (Energy Statistics Yearbook) by the Ministry of Mines and Energy of Brazil.

¹²Minerals Questionnaire, 1998-2002; Petrobrás Annual Report, 2002; and Petrobrás Magazine, 1999-2003.

TABLE 2
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 2002

(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) [Companhia Vale do Rio Doce (CVRD), 51%; Nippon Amazon Alumínio Co. (NAAC), 49%]	Belém and Vila do Conde, Pará State (two smelters)	400 (metal).
Do.	Alcan Alumínio do Brasil S.A. [Alcan Aluminum Ltd. (Alcan), 100%]	Saramenha, Minas Gerais State (smelter and refinery)	100 (metal).
Do.	do.	do.	150 (alumina).
Do.	Alcan Empreendimentos Ltda. (Alcan Alumínio do Brasil S.A., 100%)	Lamininação de Pindamonhangaba, São Paulo State (smelter)	280 (metal).
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. [Aluminum Co. of America (Alcoa), 54%; BHP Billiton, 36%; Alcan, 10%]	Poços de Caldas, Minas Gerais State (mine)	400 (bauxite).
Do.	do.	São Luiz, Maranhão State (refinery)	550 (alumina).
Do.	do.	São Luiz, Maranhão State (smelter)	239 (metal).
Do.	Alumínio do Brasil Nordeste S.A. (Alcan Aluminum Ltd., 100%)	Aratu, Bahia State (smelter)	120 (metal).
Do.	Billiton Metais S.A. (Billiton plc, 100%)	São Luis, Maranhão State (refinery)	375 (metal), 450 (alumina).
Do.	Alumínio do Norte do Brasil S.A. (Alunorte) (private, 100%)	Barcarena, Pará State (refinery)	1,550 (alumina).
Do.	Companhia Brasileira de Alumínio (CBA) (private, 100%)	Poços de Caldas, Minas Gerais State (mine)	1,000 (bauxite).
Do.	do.	Sorocaba, São Paulo State (refinery)	500 (alumina).
Do.	do.	Sorocaba, São Paulo State (smelter)	220 (metal).
Do.	Companhia Geral do Minas (private, 21%; Aluminum Co. of America, 79%)	Poços de Caldas, Minas Gerais State (refinery)	275 (alumina).
Do.	do.	Poços de Caldas, Minas Gerais State (smelter)	90 (metal).
Do.	Mineração Rio do Norte S.A. (MRN) (CVRD, 40%; CBA, 10%; Alcan Empreendimentos Ltda., 12%; Billiton plc, 14.8%; Norsk Hydro Comercio e Industria, 5%; Reynolds Alumínio do Brasil, 5%; Alcoa, 13.2%)	Oriximina, Pará State (mine)	11,000 (bauxite).
Do.	do.	Papagalo, Pará State (mine)	2,000 (bauxite).
Do.	do.	Trombetas, Pará State (mine)	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%; others, 8.8%)	Jabuti, Pará State (mine)	1,500 (bauxite).
Do.	do.	Jabuti, Pará State (alumina)	1,200 (alumina).
Chromite	Coítezeiro Mineração S.A. (COMISA) (private, 75.4%; Bayer do Brasil S.A., 24.6%)	Campo Formoso, Bahia State (mine)	50 (ore).
Do.	Companhia de Ferro Ligas da Bahia (FERBASA) (private, 100%)	Campo Formoso, Bahia State (mine)	370 (ore).
Do.	do.	Campo Formoso, Bahia State (beneficiation plant)	292 (concentrate).
Columbium (niobium)	Companhia Brasileira de Metalurgia e Mineração (Grupo Moreira Sales S.A., 55%; Molycorp, Inc., 45%)	Araxá, Minas Gerais State (mine)	1,200 (ore).
Do.	do.	Araxá, Minas Gerais State (beneficiation plant)	50 (pyrochlore).
Do.	Mineração Catalão de Goiás Ltda. (MCGL) (Bozzano Simosen S.A., 68.5%, and Anglo American plc, 31.5%)	Ouvidor and Catalão I, Goiás State (mines)	700 (ore).
Do.	do.	Ouvidor, Goiás State (plants)	13 (pyrochlore).

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 2002

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS--Continued			
Copper	Mineração Caraíba S/A (Grupo PARANAPANEMA, 100%)	Jaguari, Bahia State (mine)	130 (ore).
Do.	do.	Jaguari, Bahia State (beneficiation plant)	90 (concentrate).
Do.	Caraíba Metais S/A (CMSA) (private, 100%).	Camaçari, Bahia State (refinery)	220 (metal).
Ferroalloys	Companhia Brasileira Carbureto de Calcio (private, 100%)	Santos Dumont, Minas Gerais State (plant)	54.
Do.	Prometal Produtos Metalúrgicos S.A., 60%; Elkem A/S, 40%	Marabá, Pará State (plant)	500.
Do.	Nova Era Silicon S.A. (CVRD, 49%; Mitsubishi Corp., 25.5%; 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) (private, 100%)	Barbacena, Caxambu, Jeceaba, Passa Quatro, and Passa Vinte, Minas Gerais State; Corumba, Matto Grosso do Sul State; and Xanxere, Santa Catarina State	326.
Do.	Italmagnesio S.A. Indústria e Comercio (ISAIC) (private, 100%)	Braganca Paulista, São Paulo State; and Varzeada Palma, Minas Gerais State (two plants)	63.
Gold	kilograms Companhia Vale do Rio Doce (CVRD) (CVRD-Companhia Siderúrgica Nacional, 100%)	Gold mines in the States of Minas Gerais, Bahia, and Pará	18,000.
Do.	do. Mineração Morro Velho S.A. (AngloGold Ltd., 100%)	Novo Lima, Raposos, and Sabara, Minas Gerais State; and Jacobina, Bahia State (four mines)	7,000.
Do.	do. Mineração Serra Grande S.A. (AngloGold Ltd., 50%; TVX Gold Inc., 50%)	Serra Grande, Minas Gerais State (mine)	6,000.
Do.	do. São Bento Mineração S.A. (Eldorado Gold Corp., 100%)	Santa Barbara, Minas Gerais State (mine)	4,000.
Do.	do. Rio Paracatu Mineração S.A. (Rio Tinto plc, 51%; Autram S/A, 49%)	Paracatu Mine, Minas Gerais State (mine)	7,500.
Do.	do. Mineração Maracá S.A. (MMSA) (private, 100%)	São Vicente Mine, Mato Grosso State (mine)	1,500.
Iron ore	Companhia Siderúrgica Nacional (CSN) (private, 100%)	Volta Mine, Minas Gerais State	12,000.
Do.	Itaminas Comércio de Minérios S.A. (private, 100%)	Itaminas, Minas Gerais State	5,000.
Do.	Companhia Vale do Rio Doce (CVRD) (CVRD-Companhia Siderúrgica Nacional, 100%)	Serra dos Carajás, Pará State	55,000.
Do.	do.	Itabira, Ouro Preto, Santa Barbara, Xavier, Tamandúa, Capao, and Mato, Minas Gerais State (seven mines)	105,000.
Do.	Ferteco Mineração S.A. (FERTECO) (Exploration Bergbau GmbH, 100%)	Ouro Preto and Brumadinho, Minas Gerais State (two mines)	12,800.
Do.	S.A. Mineração da Trindade (SAMITRI) (private, 100%)	Mariana, Rio Piracicaba, Itabira, Ouro Preto, and Sabara, Minas Gerais State (five mines)	9,300.
Do.	Minerações Brasileiras Reunidas S/A (MBR) (BHP Ltd., 85.3%; Mitsui e Co. Ltd., 14.7%)	Capão Xavier, Tamandúa, and Capitão do Mato, Minas Gerais State (three mines)	32,000.
Do.	Samarco Mineração S.A. (SAMITRI, 51%; BHP Ltd., 49%)	Alegria, Minas Gerais State (mine)	13,500.
Do.	SOCOIMEX S.A. (CVRD, 100%)	Mato, Minas Gerais State (mine)	7000
Lead	Mineração Boquira S.A. (MBSA) (private, 100%)	Boquira, Bahia State (mine)	300 (ore).
Do.	do.	Boquira, Bahia State (beneficiation plant)	310 (concentrate).
Manganese	Companhia Vale do Rio Doce (CVRD) (CVRD-Companhia Siderúrgica Nacional, 100%)	Corumba, Minas Gerais State (mine)	2,500 (ore).
Do.	do.	Igarapé Azul, Carajás, Pará State (beneficiation plant)	1,400 (concentrate).
Do.	Urucum Mineração S.A. (CVRD, 100%)	Corumba and Ladario, Mato Grosso do Sul State (two mines and plant)	1,500 (ore), 800 (concentrate).
Do.	Construtora Polares Ltda. (CPL) (private, 100%)	Corumba, Minas Gerais State (mine)	200 (ore).
Nickel	Companhia Niquel Tocantins (Grupo Votarantin, 100%)	Niquelândia, Goiás State (mine)	20 (ore).
Do.	do.	Niquelândia, Goiás State (refinery plant)	10 (electrolytic nickel).
Do.	Mineração Serra da Fortaleza (Rio Tinto plc, 100%)	Fortaleza, Minas Gerais State (mine)	19 (nickel matte).
Do.	CODEMIN S.A. (Anglo American plc, 100%)	Niquelândia, Goiás State (refinery)	20 (metal).

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 2002

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS--Continued			
Steel	Aço Minas Gerais S.A. (AÇOMINAS) (private, 100%)	Rodovia, Minas Gerais State	2,000.
Do.	Companhia Aços Especiais Itabira (Government, 90.9%; private, 9.1%)	Timoteo, Minas Gerais State (stainless steel plant)	600.
Do.	Companhia Siderúrgica Belgo-Mineira (private, 100%)	João Monlevade, Minas Gerais State	1,000.
Do.	Companhia Siderúrgica de Tubarão (private, 100%)	Serra, Espírito Santo State	3,000.
Do.	Companhia Siderúrgica Nacional (CSN) (private, 100%)	Volta Redonda, Rio de Janeiro State	4,600.
Do.	Companhia Siderúrgica Paulista (COSIPA) (private, 100%)	Cubatão, São Paulo State	3,900.
Do.	Usinas Siderúrgicas de Minas Gerais, S.A. (USIMINAS) (private, 100%)	Ipatinga, Minas Gerais State	4,400.
Tin	Mineração Jacunda Ltda. (MJL) (private, 100%)	Santa Barbara, Novo Mundo, and Potosi, Rondônia State (six mines)	108 (ore).
Do.	do.	Santa Barbara, Novo Mundo, and Potosi, Rondônia State (three beneficiation plants)	450 (concentrate).
Do.	Grupo PARANAPANEMA (private, 100%)	Aripuana, Mato Grosso State; Ariquemes, Rondônia State; Novo Aripuana, Pitinga, and Presidente Figueiredo, Amazonas State; and São Felix do Xingu, Pará State (five mines and two plants)	5,420 (ore).
Do.	do.	Piraporada Bom Jesus, São Paulo State (refinery)	1,400 (concentrate), 25 (metal).
Do.	Marmoré S.A. (Grupo PARANAPANEMA, 100%)	Juiz de Fora, Minas Gerais State (mine)	20 (ore).
Zinc	Companhia Mineira de Metais S.A (Grupo Votarantin, 100%)	Vazante, Minas Gerais State (mine)	800 (ore).
Do.	do.	Vazante, Minas Gerais State (beneficiation plant)	48 (concentrate).
Do.	do.	Três Marias, Minas Gerais State (refinery)	165 (metal).
Do.	Companhia Paraibuna de Metais S.A (CPM) (Grupo PARANAPANEMA, 100%)	Juiz de Fora, Minas Gerais State (mine)	100 (ore).
INDUSTRIAL MINERALS			
Asbestos	Sociedade Anônima Mineração de Amianto (private, 100%)	Cana Brava and Minaçu, Goiás State (mines)	9,000 (ore).
Do.	do.	Cana Brava and Minaçu, Goiás State (beneficiation plant)	230 (concentrate).
Cement	Cimento Santa Rita S.A. (CSSA) (CSSA, 50%; Holder Cimento S.A., 50%)	Itapevi and Salto de Pirapora, São Paulo State (two plants)	2,200.
Do.	Companhia Cimento Portland Itau (Grupo Votarantin, 100%)	Itau de Minas, Minas Gerais State (three plants)	2,400.
Do.	Companhia de Cimento Portland Paraíso (CCPP) (CCPP, 50%; Lafarge Group, 50%)	States of Espírito Santo, Goiás, Minas Gerais, and Rio de Janeiro (five plants)	4,000.
Do.	Companhia de Cimento Portland Rio Branco (Grupo Votarantin, 100%)	Rio Branco do Sul, Paraná State (two plants)	5,000.
Do.	Camargo Correia Cimentos S.A. (CCSA) (private, 100%)	Ijací, Minas Gerais State (plant)	1,600.
Diamond	Mineração Tejucana S.A. (MTSA, 100%)	Diamantina, Minas Gerais State (mine)	100.
Fluorspar	Mineração Nossa Senhora do Carmo Ltda. (private, 100%)	Cerro Azul, Paraná State (two mines)	180 (ore).
Do.	Mineração Santa Catarina Ltda. (MSCL) (private, 100%)	Morro da Fumaça, Santa Rosa de Lima, Rio Fortuna, Santa Catarina State; and Tangúá, Rio de Janeiro State (three mines and beneficiation plant)	100 (ore), 120 (concentrate).

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 2002

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
INDUSTRIAL MINERALS--			
Continued			
Graphite	Nacional de Grafite Ltda. (NGL) (private, 100%)	Itapecerica, Pedra Azul, Salto da Divisa, Minas Gerais State (three mines)	80 (ore).
Do.	do.	Itapecerica, Pedra Azul, Salto da Divisa, Minas Gerais State (three beneficiation plants)	60 (concentrate).
Do.	Grafita MG Ltda. (GML) (private, 100%)	Mateus Leme, Zerra Azul, Minas Gerais State (two mines)	20 (ore).
Do.	Marmoré Mineração e Metalurgia Ltda. (MML) (Grupo PARANAPANEMA, 100%)	Maiquinique, Bahia State (mine)	10 (ore).
Gypsum	Companhia Brasileira de Equipamento (private, 100%)	Codo, Maranhão State, and Ipubi, Pernambuco State (two mines)	100.
Do.	Companhia de Cimento Portland Paraiso (private, 100%)	Ipubi, Pernambuco State (mine)	50.
Kaolin	Caulim da Amazônia S.A. (CADAM) (private, 100%)	Mazagão, Amapá State (mine)	720 (ore).
Do.	do.	Mazagão, Amapá State (beneficiation plant)	360 (concentrate).
Do.	do.	Adam Mine, Rio Jarí, Amazonas State	660 (concentrate).
Do.	Pará Pigmentos S.A. (PPSA) (private, 100%)	Pará Mine, Pará State	500 (concentrate).
Do.	Ymerys Rio Capim Caulim S.A. (RCCSA) (private, 100%)	Rio Capim Mine, Pará State	500 (concentrate).
Do.	Empresa de Mineração Horii Ltda. (EMHL) (private, 100%)	Biritiba and Mogi das Cruzes, São Paulo State (two mines)	200 (ore).
Do.	do.	Biritiba and Mogi das Cruzes, São Paulo State (two beneficiation plants)	180 (concentrate).
Limestone	Companhia de Cimento Portland Paraiso (CCPP) (private, 100%)	States of Goiás, Minas Gerais, and Rio de Janeiro (five mines)	2,000.
Do.	Companhia de Cimento Portland Rio Branco (CCPRB, 100%)	Rio Branco do Sul, Paraná State (three mines)	5,500.
Do.	S.A. Industrias Votorantim (SAIV) (private, 100%)	States of Rio de Janeiro and São Paulo (four mines)	1,000.
Magnesite	Magnesita S.A. (MSA) (private, 100%)	Brumado, Bahia State (one major mine and numerous small mines)	1,000 (ore).
Do.	do.	Brumado, Bahia State (two beneficiation plants)	280 (concentrate).
Phosphate rock	Fertilizantes Serrana S.A. (Bunge International Group, 100%)	Araxá, Minas Gerais State (mine)	5,000.
Do.	Copebras S.A. (Copebras) (Anglo American plc, 100%)	Ouvidor, Goiás State (mine)	4,400.
Do.	Fosfértil S.A. (Grupo Fertifós, 79%; CVRD, 11%; public, 10%)	Tapira, Minas Gerais State (two mines)	10,500.
Do.	Ultrafértil S.A. (Grupo Fertifós, 79%; CVRD, 11%; public, 10%)	Araxá, Minas Gerais State (mine)	5,000.
Quartz	Telequartzo Exportação S.A. (TESA) (private, 100%)	Cristal, Minas Gerais State (mine)	6.
Salt, rock	Frota Oceânica Brasileira S.A. (FOBSA) (private, 100%)	Jacupiranga, São Paulo State (mine)	6,000.
Do.	Dow Química do Nordeste Ltd. (DQNL) (Dow Chemical Co., 100%)	Vera Cruz, Bahia State (mine)	1,000.
Do.	Cia. Nacional de Alcalis S.A. (CNA) (private, 100%)	Alcalis Grupo, Rio Grande do Norte State	1,500.
Do.	Salgema Mineração e Química S.A. (SMQ) (private, 100%)	Salgema, Maceió, Alagoas State (mine)	1,000.
Titanium	Rutilo e Ilmenita do Brasil S.A. (RIBSA, 100%)	Mataraca, Paraíba State (mine)	4,200 (ore).
Do.	do.	Mataraca, Paraíba State (two beneficiation plants)	120 (concentrate).
Zirconium	Nuclemon Mineró-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)	90 (ore).
Do.	do.	Prado, Bahia State (three beneficiation plants)	123 (concentrate).
Do.	do.	Prado, Bahia State (three separation plants)	90 (concentrate).

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 2002

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
MINERAL FUELS			
Coal	Carbonifera Ciriúma S.A. (CCSA) (private, 100%)	Ciriúma and Siderópolis, Santa Catarina State (two mines)	1,600.
Do.	Companhia Carbonífera Metropolitana S.A. (private, 100%)	Ciriúma, Siderópolis, and Urussanga, Santa Catarina State (three mines)	1,200.
Do.	Copelmi Mineração Ltda. (COPELMI) (private, 100%)	Arroio dos Ratos, Butia, and Charqueadas, Rio Grande do Sul State (four mines)	4,600.
Do.	Companhia Riograndense de Mineração S.A. (private, 100%)	Ciriúma and Urussanga, Santa Catarina State (two mines)	2,600.
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	220,000.
Petroleum products	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. (private, 100%)	Ipiranga, Rio Grande do Sul	3,400.
Do.	Refinaria de Petróleos de Manguinhos S.A. (private, 100%)	Manquinhos, Rio de Janeiro State	3,650.

TABLE 3
BRAZIL: RESERVES OF MAJOR MINERAL COMMODITIES IN 2002¹

(Thousand metric tons unless otherwise specified)

Commodity	Reserves	World ranking	World percent
Asbestos, fiber	16,000		NA
Bauxite, ore	2,510,000	3	7.8
Chromite, Cr ₂ O ₃	7,100		0.1
Coal, all types	7,372,000		0.6
Columbium, pyrochlore, and columbite ore	5,200	1	98.0
Copper, metal content	17,400		1.8
Fluorspar, ore	3,100		1.0
Gold, metal content metric tons	2,000		2.0
Graphite, ore	95,000	2	26.0
Gypsum	1,269,000		NA
Iron ore, 60% to 65% Fe content	21,000	5	6.5
Kaolin	4,050,000	3	29.0
Lead, metal content	1,000		0.7
Magnesite	180,000	4	8.2
Manganese, metal content	152,000	4	3.0
Natural gas ² million cubic meters	240		NA
Nickel, metal content	6,000		4.0
Petroleum ² thousand 42-gallon barrels	9,800		0.8
Phosphate rock	260,000		0.8
Talc and pyrophyllite	156,000	3	17.0
Tantalum, Ta ₂ O ₅ metric tons	89,000	1	52.0
Tin, metal content	2,500	2	22.0
Titanium, TiO ₂	7,200		0.7
Vermiculite	23,000	3	10.0
Uranium, U ₃ O ₈ metric tons	163,000		NA
Zinc, metal content	5,200		1.2
Zirconium, ore	2,000		2.8

NA Not available.

¹Sumário Mineral 2002-03.

²Petróleo Brasileiro, S.A. annual report 2002-03.