

THE MINERAL INDUSTRY OF

CHILE

By Pablo Velasco

In 1997, Chile continued to be the top producer and exporter of copper, in terms of volume 3.3 million tons and value \$6.9 billions respectively producing 29.7% of the world's mined copper. Chile was recognized by the world mining community as being the single most active mining country, in terms of new development and investment; of the total \$5.04 billion in foreign investment, about 32% went to the mining sector.

Direct foreign investment in the mining sector, which was permitted by Foreign Investment Statute Decree Law 600 of 1994, rose to \$1.65 billion from \$995 million in 1996. Chile was also one of the world's significant producers and exporters of potassium nitrate and sodium nitrate and ranked first in lithium, second in iodine, molybdenum and rhenium.

Figures released by the National Institute of Statistics of Chile for 1997 indicated that the gross domestic product (GDP) increased by 7.1%, to about \$77 billion¹ at current prices. Inflation decreased to 6.1%, and unemployment, 5.3%. Per capita income increased by 3.9%, to about \$5,300 (U.S. Embassy, Santiago, Chile, 1999).

Corporación Nacional del Cobre de Chile (CODELCO), invested \$873 million in 1997, 23% higher than in the previous year. (Corporación Nacional del Cobre de Chile, 1997).

Mining is central to the Chilean economy. Nitrates provided more than 70% of export earnings for several years at the beginning of the century, and copper provided in excess of 50% of export earnings during the past 30 years. In 1997, mining provided more than 8% of the GDP and provided 50% of export revenue and continued to be the most attractive sector for foreign investment, absorbing about 56% of the total foreign investment. Half the total foreign investment in mining was spent in Region I. Of this amount, the bulk was accounted for by the development of the Doña Ines de Collahuasi Mine, which was running ahead of schedule for production in August 1998. (Mining Journal, 1998a).

Government Policies and Programs

Foreign investment in Chile increased greatly as a result of Decree Law 600, which served as the most significant guideline for investment, the increased economic and political stability in the country brought on by the return to democracy in 1990. The two main legal mechanisms for investment in Chile are through the formal market—Decree Law 600 and Chapter XIV of the Compendium of Foreign Exchange Regulations of the Central Bank of Chile.

Decree Law 600, the main legal framework for foreign investment, covers types of capital contributions, taxes, foreign

exchange (repatriation of profits and capital), and administrative procedures (authorization, registration, etc.). The framework was based on economic and legal principles found in the Constitution of Chile, an important aspect of the Decree Law is the idea of nondiscrimination. It offers all foreign investors, on a most-favored-nation basis, the same legal treatment as nationals and guarantees a stable framework by means of investment contracts signed between foreign investors and the Government. This contract may not be modified by either party unilaterally and is not affected by the passage of new laws. Investment can be made through convertible currencies, tangible assets, technologies that can be capitalized, and loans tied to foreign investment projects. Repatriation of capital and profits is guaranteed through the formal currency market. The Central Bank can demand that transactions for export or import, foreign loans, capital, and profit remittance be conducted through the bank.

Chile also offered foreign investors political stability, a modern business environment, accelerated depreciation for tax purposes, deferral of customs duty for export activities, and taxation of retained earnings. Capital can be repatriated after 1 year with no restriction for the remittance of profits. More than 6% of foreign investment in Latin America was in Chile; 2.5% of the total in developing countries. Foreign investment has played an important role in the modernization and growth of the Chilean economy. The only sectors that have attracted direct foreign investment have been industrial, mining, and service.

Although access to local financing by foreign investors was not currently restricted, Decree Law 600 provides that any such restriction of access to local financing imposed on foreign investment would not be viewed as discriminatory. This applies to projects that cost more than \$60 million, which are regulated by Article 11 of the Foreign Investment Statute.

Environmental Issues

The Government of Chile has made protecting the environment a priority. The Environmental Framework Law, known as the "Basic Law", was signed by the President of Chile in 1994. It established the National Commission on the Environment [Comisión Nacional del Medio Ambiente (CONAMA)] and 12 Regional Environmental Commissions [Comisiones Regionales del Medio Ambiente (COREMA)] to coordinate environmental protection activities among Government agencies. CONAMA defines Chile's environmental policy, proposes environmental legislation, and develops and maintains the resources necessary for the administration and enforcement of environmental regulations. Each COREMA comprises representatives from regional governments, the private sector, and nongovernmental organizations and is charged with the implementation and enforcement of new regulations. COREMA regional subsidiaries

¹Where necessary, values have been converted from Chilean pesos (Ch\$) to U.S. dollars at the rate of Ch\$419.0=US\$1.00, the average exchange rate in 1997.

authorize pollution prevention and abatement plans, advise the Ministry of Mining on designing environmental policies and the regulations implementing these policies, diagnose environmental impacts, and develop general environmental objectives and policy responses.

Regulations implementing the Basic Law established equal rights and responsibilities for public and private enterprises. The Government planned to phase in the provisions gradually to minimize disruptions to the economy and to allow time to develop monitoring and enforcement capabilities. The Government had promulgated two decrees intended to reduce fixed-source air pollution (Decree Law 185 of 1991, which regulated sulfur dioxide emissions) and implemented regulations pertaining to the disposal of waste water from mine tailings in coastal zones and took some initial steps to contain and reduce air pollution around Santiago.

Decree Law 185 divided Chile into—the mining district (Zone 1), which covers more than one-half of the country from Rancagua, site of the El Teniente smelter, to the border with Peru) and the agricultural/industrial part of the country (Zone 2), from the area south of Rancagua to Tierra del Fuego. The decree stipulated that Zone 1 must meet emission standards published by the U.S. Environmental Protection Agency and that Zone 2 must meet the considerably higher air-quality standards in force in Scandinavia.

Under pressure from the Atacama Environmental Health Service and the Chilean Federal Government, Empresa Nacional de Minería (ENAMI) installed a sulfur-recovery plant to control sulfur dioxide emissions at its Hernan Videla Lira (Paipote) smelter. ENAMI will continue a \$8.6 million contract with a Santiago-based construction company to install an additional sulfuric acid plant at Paipote; the acid plant will be moved from the old Chagres smelter, which was replaced with a new flash furnace smelter by Exxon's Cía. Minera Disputada de Las Condes S.A. in the Catemu Valley 90 kilometers (km) north of Santiago; Exxon is a U.S. petroleum company.

At CODELCO's El Teniente Division, production continued while exercising environmental responsibility, such as construction of the first sulfuric acid plant, which was scheduled to be completed in August 1998. This project will focus on the Caletones smelter and the neighboring towns of Caletones and Coya. The total cost of these measures would be about \$300 million. In 1997, the Division will start construction of a \$72 million sulfuric acid plant at its Caletones smelter, the first of two such facilities that will allow the smelter to meet new environmental standards due to come into force in 2003. CODELCO announced that the contract for the construction of the first plant had been awarded to Mitsubishi Corporation of Japan. The cost of this construction alone will be \$50 million. The plant will have a production capacity of 1,500 metric tons per day (t/d) of sulfuric acid. When fully operational, the two plants are expected to reduce sulfur emissions at the Caletones Smelter by more than 50%, to 115,000 Metric Tons Per Year (t/yr). (Weekly Mining News, 1996b).

In 1997, El Teniente Division also placed a high priority on the disposal or storage of water used in the mining process. To this end, surplus water has been stored in several reservoirs at Agua Amarga, Arena, Barahona, Cauquenes, and Colihues. The most recent reservoir built for this purpose by CODELCO was at Carén. This reservoir was fed by a number of drainage channels

that take the water from the mine to the tailings dam (Weekly Mining News, 1996).

Minera Escondida Ltda.'s (Escondida) operations west of Antofagasta where subject to high environmental management standards. Prior to its production startup, Escondida carried out ecological baseline studies in its operation areas. In the case of the port of Coloso, south of Antofagasta, Escondida prepared an environmental impact study and designed a wide monitoring and environmental control program for its activities. The study was approved by the COREMA of Region II, near Antofagasta where the mine is located.

Collahuasi had water rights in the Coposa basin where 14 wells where constructed, of which 8 are normally in operation at one time. It also had rights to water in Salar de Michincha, but these where not expected to be used. The average water requirement at the Collahuasi site was 600 liters per second (L/s), of which 537 L/s, was used by the sulfide plant.

At Punta Patache, sea water was treated by a reverse-osmosis plant to produce potable water. The development plan conformed to Chilean environmental laws and regulations in all aspects, including particulate matter, effluent and liquids, noise, and solid waste emissions and disposal. Comprehensive studies and site campaigns completed between 1993 and 1995 were used to identify the sources and remedies of environmental impact. The environmental impact assessment that was approved by the environmental authorities in 1995 had been conducted according to World Bank standards. This will be a zero-discharge operation with no waterborne effluents from either the concentrator or the port site. The plan ensured containment of environmentally sensitive substances from floatation, leaching, and solvent extraction processes. Water in the tailings dams at Collahuasi is reclaimed by runoff control for use in the sulfide plant. Water filtered from the concentrate slurry at Punta Patache was utilized to irrigate a eucalyptus tree plantation. A diversion ditch at Punta Patache will be left in place after closure to divert runoff from entering the sea. A comprehensive monitoring plan was in place to ensure environmental protection.

Production

In 1997 the Chilean Copper Commission (COCHILCO) reported that Chilean copper production increased by 8.9%, to 3.39 million metric tons per year (Mt/yr), compared with that of 1996; 1.23 Mt/yr was contributed by CODELCO, or about 36% of the total, and the remainder or about 64% by the private sector. Servicio Nacional de Geología y Minería (SERNAGEOMIN), an agency of the Ministry of Mines, reported gold production for Chile decreased by 7%, to 49,459 kilograms (kg) and silver production by 5%, to 1.09 million kilograms (Mkg), respectively. The medium- and small-sized mines produced 97% of the gold and 77% of the silver in the country, and the large-sized mines of CODELCO produced 3% of the gold and 23% of the silver produced primarily as byproducts of the copper operation.

CODELCO also accounted for all the output of molybdenum as molybdenum trioxide and was a major sulfuric acid producer. In 1997, production reached 21,339 metric tons (t), making Chile the world's second most important producer after the United States.

The increase in production of copper by the private sector in 1997 established a new benchmark in Chile's historical copper

output chiefly because of the startup of five new copper mine projects—La Escondida expansion, La Candelaria, El Abra copper mine, Quebrada Blanca, and Cerro Colorado—and the increase in output of the second phase of the copper cathode production from the Minera Michilla project. Production of industrial minerals increased significantly compared with that of 1996. (See table 1.)

Trade

Chile's economy was highly dependent on international trade. In 1997, total exports reached \$17.0 billion, and imports, \$18.9 billion. Exports accounted for 22% of the GDP. Although Chile has been dependent upon traditionally such as copper and other minerals exports, nontraditional exports have grown at a faster rate, such as nitrates and iodine accounting for 52% of export earnings. Chile's export markets were geographically diverse. Asia and the European Union were the largest regional markets. The United States, the largest single market, took in about 17% of Chile's exports. Chile signed free trade agreements with Colombia, Ecuador, Mexico, and Venezuela. An association agreement with Mercado Común del Sur [Southern Cone Common Market (MERCOSUR), (Argentina, Brazil, Paraguay, and Uruguay)] went into effect in October 1996. Chile's 1996 free trade agreement with Canada was modeled largely on North American Free Trade Agreement (NAFTA) in anticipation of an eventual trade pact with the United States. (U.S. Department of State, October 1998, Chile, List server, sent October 27, 1998, from e-mail DOSBACK@LISTSERV.UIC.EDU).

Besides copper, Chile's other minerals exports were ferromolybdenum, gold, iodine, iron ore, iron pellets, silver, sodium nitrate, lithium carbonate, molybdenum oxide, nitrate, potash, and zinc. In 1997, CODELCO shipped 1.4 million metric tons (Mt) of fine copper, 14% more than was shipped in 1996.

Revenues from copper sales by CODELCO were about \$2.7 billion, or \$69 million more than those of 1996. Revenues from other copper sales reached \$444 million; those from the sale of byproducts amounted to \$329 million, \$73 million higher than those of 1996, which included \$168 million from sales molybdenum, doré metal, sulfuric acid, and others (Corporación Nacional del Cobre de Chile, 1997).

Structure of the Mineral Industry

The Chilean Government, through the Ministry of Mines, exercised dominant control over the mineral industry through three large, state-owned mining companies and four regulatory agencies. The mining companies were CODELCO, ENAMI, and Corporación de Fomento de la Producción (CORFO). Subsidiaries of CORFO included Cía. de Acero del Pacífico, S.A. de Inversiones (CAP); Empresa Nacional del Petróleo S.A. (ENAP); Empresa Nacional del Carbón S.A. (ENACAR); Cía. Chilena de Electricidad, S.A.; and Sociedad Química y Minera de Chile S.A. (SQM). The four regulatory agencies were SERNAGEOMIN, COCHILCO, the Foreign Investment Committee, and CONAMA.

In 1997, CODELCO, comprised four divisions—Andina, Chuquicamata, El Teniente, and El Salvador—that accounted for 38.6% of all Chilean copper production, including output of copper from El Abra, a copper deposit that came into production

in November 1996. The Rodomiro tomic startup operation generated 4,049 tons of fine copper. CODELCO was also a producer of gold, metal doré, molybdenum (trioxide and concentrate), rhenium, and silver, as well as ammonium perrhenate (rhenium) and sulfuric acid.

ENAMI purchased concentrates of copper, gold, and silver; precipitate and minerals for direct smelting; and anodes and blister for its smelters and refineries. It served as a market-regulating force by determining rates for minerals and mining products bought from producers in potentially attractive mining zones, provided credit to miners who lacked access to standard sources of financing, facilitated miners' access to banking sources, and provided training and support programs to small-sized mines. In addition, ENAMI produced, sold, and distributed sulfuric acid; participated with private investors in the development of small- and medium-sized mining projects; guarded against potential environmental harm from mining production; and bought ores for flotation and leaching at its own plants.

In 1997, the total labor force in Chile was about 5.2 million—36%, industry and commerce; 34%, agriculture, forestry, and fishing; 14%, construction; and 7%, mining. The mineral industry employed 56,354 (including staff and office personnel working directly for the mineral sector). The metal sector employed about 46,964 workers, the industrial mineral sector employed 4,809 miners, and the mineral fuel sector employed 4,581 (including almost 3,000 coal miners). CODELCO employed about 38,062 people (including its own copper workers and contractors' personnel), or about 68% of the mineral industry.

Commodity Review

Metals

Copper.—In 1997, Chile's increased copper production reinforced its position as the world's largest producer and exporter of copper. According to official statistics released by the Ministry of Mines through its agencies COCHILCO and SERNAGEOMIN, Chile produced another record high of 3.39 mt of copper, an 8.9% increase from that of 1996. The increase in production was due to increased output from the small and medium-sized mining sector, which accounted for 64.3% of the total. An important aspect of the copper mining boom is the emergence of the solvent extraction and electrowinning (SX-EW) process for the low-cost recovery of refined copper. SX-EW production of copper increased by 38.6% to 881,100 t, compared with that of 1996 and was forecasted to increase fourfold during the next few years. By the turn of the century, Chile and Peru will probably provide more than 50% of the world's output of this form of copper, which could have serious implications for production costs.

Although CODELCO was the world's largest copper-producing company, the private sector produced more copper as a result of the development of many new mines financed by foreign private investment. Copper output was expected to increase significantly in the next few years as more private sector projects come on-stream. CODELCO increased its output by 7.2%, to 1.33 Mt of fine copper with an average grade of 1.15% copper, compared with that of 1996, generating a return of more than \$1.0 billion,

which included 49% production from El Abra. El Abra, a high-altitude mine, started up 6 months ahead of schedule and within budget, and began commercial production in December 1996. Total investment in the project was \$1.8 billion. The project, owned by Cyprus Amax Minerals Co. of the United States (51%) and CODELCO (49%), was the world's largest copper heap-leach operation. In 1997, production was 95,166 t at a direct cost of less than \$0.40 per pound.

CODELCO's new Rodomiro Tomic Division, located at 40 km north of the city of Calama, had a copper deposit with geological reserves of 2,510 Mt containing an average grade of 0.59% copper. With an initial capital investment of \$641 million, the mine was designed with a production capacity of 150,000 t/yr. Its final product will be copper cathodes of high purity at a direct operating cost of less than \$0.40 per pound (Corporación Nacional del Cobre de Chile, 1997).

Doña Inés de Collahuasi, the fourth largest copper mine project in the world, opened horizons for Falconbridge, Minorco and Mitsui Group (Mitsui & Co., Nippon Mining & Metals Co., and Mitsui Mining & Smelting Co.). High on the Altiplano of the Andes, 200 km southeast of the resort city of Iquique, in Region I, the Collahuasi Mine is a porphyry copper deposit containing more than 3 billion metric tons of mineral reserves and resources grading 0.79% copper in three near-surface copper deposits. Two of these deposits (Ujina and Rosario) containing more than 100 Mt of ore at an average of 2% copper were being exploited by open pit mining. In the first year, production was expected to be about 450,000 t of copper—10% of the Chilean copper 3.5% of world copper production. When the operation comes on-stream in 1998, the copper will be processed through a heap-leaching and SW-EX plant. According to the General manager, engineering was 80% ahead of schedule, and the project should produce its first copper cathodes by August 1998. Callahuasi is an important part of a new period of growth in the Region I. The project is close to two other large copper mines, the Quebrada Blanca Mine (Cominco International Ltd./Teck Resources International Ltd., 76.5%; Sociedad Minera Pudahuel Ltd., 13.5%; and ENAMI, 10%) and the Cerro Colorado Mine (Rio Algom Ltd., of Toronto, Canada, 100%) (Weekly Mining News, 1996g).

In March 1997, a new oxide treatment plant that will produce an additional 125,000 t/yr of copper cathode was proposed for the world's largest copper mine at Escondida (Broken Hill Proprietary Company Limited of Australia, 57.5%; Rio Tinto Zinc Corp. Plc., 30%; Japan Escondida Corp., 10%; and International Finance Corp., 2.5%). Also planned was the Phase IV development worth \$367 million. Together these projects will push Escondida's production close to 1 Mt/yr. In 1996, Escondida announced development plans for the Escondida Norte expansion project, 6 km north of the Escondida site. The new deposit, which is likely to go into operation in 2001, has an estimated reserve of 400 Mt averaging 1.3% copper (Weekly Mining News, 1997).

Fundición Refimet S.A. (Inversiones Mineras del Pacifico, Minera Barrick and Noranda Inc.), the Chilean-controlled copper smelting company, announced plans for a \$100 million expansion to increase capacity from 450,000 t/yr to 680,000 t/yr by 1999. In 1997, Chile exported about 1 Mt/yr of copper concentrate and had the capacity to treat about 1.5 Mt/yr. Almost twice this amount could be produced by 2005 (Mining Journal, 1998a).

Exxon Coal & Mining Company (ECMC) announced that it

will invest \$570 million in its expansion of Los Bronces copper mine, located 70 km northeast of Santiago. The ECMC plan called for an 84.6% increase in the production of refined copper from a 1996 level of 130,000 to 240,000 t/yr by 2001. ECMC, a subsidiary of Exxon, planned to begin the work in 1998 and estimated that the expansion would be operational by 2000 and reach design capacity the following year; there also were plans to increase its treatment capacity from 75,000t/d to 37,000 t/d. ECMC will also purchase new extraction equipment. Since ECMC acquired the deposit in 1978 and began the series of expansions, investment in the project has been \$1.2 billion. The last of these expansions, which began in 1992 and cost \$440 million, enabled a tripling of production in 1996 (Weekly Mining News, 1996c).

Empresa Minera de Mantos Blancos, S.A. (Mantos Blancos), the Manto Verde SX-EW project 85 km southeast of the port of Chañaral, used seawater to leach 5.4 Mt of 0.9% copper oxide ore from an open-pit mine and to produce 53,500 t/yr of copper cathodes.

The Santa Bárbara and the Manto Verde SX-EW copper operations, owned by Mantos Blancos, are now in operation. Santa Bárbara was an expansion of an open-cast mine, north of Antofagasta. The investment, which included the installation of a new primary crusher, conveyor system, and a 30,000-t/yr cathode SX-EW circuit, totaled \$68.2 million. The company also extended the mine's life to 2010. Production should continue until the middle of the next decade at 1997 levels of around 77,400 t/yr, of which 46,000 t/yr was in the form of copper in concentrates. The SX-EW circuit produced 2,633 t of copper cathode in December 1996, its first full month of operation. The old smelter at Mantos Blancos was dismantled. At Manto Verde, the SX-EW plant produced some 570 t/yr of cathode; output in 1996, the first year of operation was 30,000 t. Manto Verde is an open-cast, heap-leach operation near El Chañaral in the Atacama region. The project has cost about \$180 million and is scheduled to produce 15,000 t/d of ore and 38,400 t/yr of cathode during the next 16 years. In November 1997, Mantos Blancos sold its copper deposit, Lomas Bayas, in Sierra Gorda (Region II), to Gibraltar Mines S.A., a Canadian mining company, for \$19 million.

A \$351 million expansion to double production was completed at the end of 1997 at La Candelaria. Owned by Phelps Dodge Corporation (80%) and the Japanese bank Sumitomo (20%), it is located in Region III. In 1996, the production of copper concentrate reached 156,000t/yr and will be increase to 225,000 t by the end of 1998 after the expansion is fully commissioned (Weekly Mining News, 1996a).

Quebrada Blanca mine in Region I, about 170 km southeast of Iquique and at 4,400 meters (m) above sea level, had operational problems with the SX-EW processes owing to the altitude. The project represented an investment of \$360 million. The deposit was controlled by Cominco (38.25%), Teck (29.25%), Minera Pudahuel (13.5%), ENAMI (10%) and Cominco International, Ltd. (9.0%). Quebrada Blanca reserves were estimated to be 90 Mt of copper with an average grade of 1.3% Cu in its secondary enrichment zone, enough to keep the mine in operation for 14 years. An additional 400 Mt of copper sulfide ore with a average grade of 0.5% Cu also was reported; the mineral was being processed by heap leaching using bacterial leaching techniques. In July 1996, Cominco acquire a share in Quebrada Blanca from Minera Pudahuel. Cathode copper production from this mine

totaled 66,878 t for the year, relatively unchanged from 1995. Higher operating costs, however, resulted in a 17% drop in operating profit. This figure was in line with company's projections at the beginning of 1996 but short of the plant's design capacity of 75,000 t/yr. (Weekly Mining News, 1996c)

Compañía Minera Cerro Colorado, S.A., the Chilean subsidiary of Rio Algom open pit and heap-leach operation from 60,000 t/yr to 73,000 t/yr of copper was to be completion in mid-1998 at a cost of \$200 million. In the first quarter of 1997, the company created a Chilean exploration subsidiary through which they intended to focus increased exploration effort. Construction would begin in March or April 1997 and take 6 months to complete.

The general manager of Compañía Minera Zaldívar said that the plant's capacity will range between 10,000 and 15,000 t/yr of copper concentrate. In October 1996, Minera Zaldívar reported that production would fall short of the 85,000-t goal by 10,000 t but that company hoped to reach production design capacity of 125,000 t by 1997. Later, the company announced that goal would be postponed until 1998 and that a new processing plant was expected to bring production up to 100,000 t in 1997 before reaching design capacity in 1998. The average production cost reached \$0.49 per pound. Company officials indicated that production was hurt by higher-than-anticipated levels of fine copper-rich mineral in the oxide deposit. Such material is too fine to be processed through the heap-leach system and was being deposited as waste in tailing dumps, which caused the drop in expected production.

Gold and Silver.—Production of gold and silver in 1997 was 49.5 t and 1,091 t, respectively; this represented a decrease of 7% and an increase of 4.9% respectively from 1996 production. Most of Chilean gold production was by medium-sized gold mines (73.2%), the large-sized mines of CODELCO produced 2.6% of the gold.

Most of the mines in the area of the Maricunga Gold Belt in Regions II, III, and IV are open pit, except El Indio-El Tambo; many are also heap-leach operations. Rising costs prompted Barrick Gold Corp. of Canada to announce in September 1997 that it would close El Indio by the end of 1998 and El Tambo by the end of 1999. Until 1991 El Indio-El Tambo had produced Chile's largest gold output. Barrick intended to employ the workforce at its 11-million-ounce-per-year Pascua project, approximately 50 km away and scheduled to come on-stream in 2001 at an estimated cost of \$900 million. Low prices and uncertainty over the ratification of the Chile-Argentina mining treaty were, however determining factors in delaying completion of the study.

Within the same gold belt as the company's El Indio operation, the Pascua Mine, formerly known as the Nevada project, has an estimated reserve of some 105.7 t of gold, considerably more than the 56 t delineated when Barrick acquired the property in 1994.

La Coipa Mine is currently the most productive mine in the gold-rich Maricunga belt located east of Copiapo in Region III. owned equally by Placer Dome, and TVX Gold Inc. of Canada.

In 1997, La Coipa became the largest gold producer in the country, with a reported production of 210,494 oz of gold and 10.28 million ounces of silver (making it one of the largest silver mines in the world) at a cash cost of US\$219 per ounce of (gold

equivalent). Proven and probable reserves at the mine at year-end totaled 77 Mt of ore averaging 0.8 grams per ton of gold (g/t) and 80.7 g/t of silver followed by CODELCO, other important producers of byproduct silver were El Indio, La Escondida, and El Bronce de Petorca. Other precious metal mines producers included Sociedad Contractual Minera Vilacollo, SCM Vilacollo Ltda., (Choquelimpie Mine and plant), Minera El Hueso (Minera Homestake Chile S.A.), San Cristóbal (Niugini Mining Ltd.), Minera Escondida Ltda., El Bronce de Petorca, and El Guanaco (AMAX Gold Inc.).

SCM Vilacollo Ltda., the company formed by Shell, Citibank, and Northgate to operate the Coquelimpie Mine near the Bolivian border, was seeking new reserves near the mine. SCM Vilacollo and Cía Minera Mantos de Oro Ltd. were reviewing financing plans to raise the required \$135 million capital investment.

El Refugio (Bema, Cyprus Amax) in Northern Chile produced a total of 48,544 oz of gold during the first quarter of 1998 at an average cash operating cost of US\$287/oz, giving a 25% increase in production over the last quarter of 1997. In September 1997, a loan facility of US\$45 million was raised to refinance El Refugio. Drill results were positive in six holes of the program of deep drilling beneath the pit floor in the Verde deposit. Current estimates placed contained gold at Refugio at around 5.3 Moz.

Iron Ore, Manganese, and Steel.—In 1997, Chilean iron production decreased by 3.8% to 8.7 Mt. The III Atacama Region contributed with 55.3%, and the IV Coquimbo Region with 44.7% of the total. From the total production, 744,402 t was consumed by the Huachipato Steel plant. The Algarrobo Mine output, which feeds the Huasco pellet plant, would be depleted by the end of this decade. The owner, Cía. Minera del Pacífico S.A. (CMP) and subsidiary of CAP, as entered into joint venture with MC Inversiones Ltda., a subsidiary of Mitsubishi Corp., to expand Los Colorados iron deposit a property of CMP in the Province of Huasco in Region III. This joint venture, known as Compañía Minera Huasco S.A. (Minera Huasco) is a closed corporation with a straight 50-50 ownership. To finance the project, Minera Huasco signed a loan contract with MV Cayman Ltd. for \$71.7 million; the total investment of the project is estimated at \$107 million. The reserves of Los Colorados are estimated to be about 245 Mt of iron ore grading 45% Fe. The expansion of the deposit will enable CMP to process the preconcentrate into pellets in its plant in Huasco, thereby producing 4 Mt/yr of pellets by 1998.

CAP is currently producing around 1 Mt/yr of iron concentrate from the deposit. Mitsubishi Corp. was to supply all the investment required for the expansion program, and CAP was to contribute the mining rights and other assets to the equally held joint venture.

Manganesos Atacama, S.A. (MASA), a Swiss-Chilean industrial group and subsidiary of CAP, owned iron mines and Chile's largest steel plant, producing ferromanganese and ferrosilicon alloys and manganese, as well as steel cones for mills in the Coquimbo plant for the domestic market. The company produced manganese ore at the El Corral Quemado and Los Loros Mine in Region IV. During 1997, production of manganese increased by 1.2% to 63,673 t compared with that of 1996. Most of the manganese produced by MASA was bought by the Huachipato smelter. The production of steel ingots at Huachipato amounted to 1.15 Mt, 1.3% higher than that of 1996. CAP

reported that to increase the production capacity at its Huachipato smelter and to reduce operating costs, it was considering an investment of \$350 million between 1995 and 1998 to modernize the plant.

Zinc.—The largest zinc mine in Chile, El Toqui Mine, operated by Sociedad Contractual Minera El Toqui, Ltda. (SCMT), is owned by LAC Minerals Ltd. of Canada and is located near Coihaique in southern Chile. Despite problems resulting from low prices, SCMT produced about 70,300 t of concentrate containing 34,000 t of zinc. Because a temporary shutdown would have cost about \$5 million, LAC Minerals opted for continued production at SCMT and cost reductions at the 1,500-t/d concentrator at Coihaique. Low zinc prices have, however, convinced the company to postpone its plans to expand SCMT.

Industrial Minerals

Lithium and Potassium.—Chile is the second largest producer of lithium in the world after the United States. Production of lithium carbonate in 1997 was 24,246 t, 71% more than that of 1996. SQM, the world's largest producer and distributor of iodine and its derivatives, announced plans to invest \$230 million during the next 4 years. This follows the \$60 million investment in 1994 that focused primarily on the Minsal project on the edge of the Salar de Atacama and a potassium nitrate plant at Coya Sur, just south of María Elena in Region II. The project and plant began operation in October 1995. This plant, owned by SQM, added a productive capacity of 100,000 t of potassium nitrate to SQM's previous 260,000 t. SQM is the major nitrate producer in Chile, and produced 847,000 t of nitrate in 1997, a 4.8% increase on 1996. An integrated producer and distributor of specialty fertilizers, industrial chemicals, iodine and lithium, SQM processes the raw materials caliche and Salar de Atacama brines in the I and II Regions. The Salar de Atacama brines contain high concentrations of lithium, potassium sulfate, boron and magnesium, allowing SQM to be one of the lowest-cost potassium chloride and lithium carbonate producers worldwide. Total sales in 1997 increased by 8.4% to US\$513.3 million. During the first half of 1998, potassium sulfate and boric acid will be added to its product list. Sociedad Minera Salar de Atacama Ltda. (Minsal), subsidiary of Soquimich extracts the brines from the Salar de Atacama, which it processes to produce potassium chloride and lithium carbonate. In 1998, SQM will also add potassium sulfate and boric acid production. The high concentrations of boron, lithium, magnesium, potassium, and sodium sulfates contained in the brines of the Salar de Atacama, as well as the favorable weather conditions of that zone, account for Minsal being one of the world's lowest cost producers of boric acid, lithium carbonate, potassium chloride, and potassium sulfate. Minsal, whose current production capacity is 350,000 t/yr, plans to increase its production of potassium chloride by more than 150,000 t/yr during the next 2 years. The main objective is to provide raw materials for the rapidly increasing production of potassium nitrate. In October 1996 (2 months ahead of schedule), Minsal began producing lithium carbonate.

Nitrates and Iodine.—Cía Minera Yolanda S.A., a Chilean

subsidiary of KAP Resources Ltd. of Canada (KAP) in the Taltal zone of Region II, was planning to produce about 357,000 t/yr of potassium nitrate, 300,000 t/yr of potassium nitrate, and 180 t/yr of iodine in 1998. The company will use heap-leaching methods and seawater to obtain a salt concentration solution by solar evaporation in ponds before crystallization. The company planned that all or part of the sodium nitrate produced would be converted to potassium nitrate by using an additional potassium chloride treatment and recrystallization; iodine would be extracted from the residual waters. A feasibility study was completed for the Yolanda iodine-nitrate property in Chile's Salar de Atacama in 1990 and then updated a few years later. Now held by a wholly owned subsidiary of KAP, the deposit contains reserves of more than 120 Mt of ore containing an estimated recoverable resource of 40,500 t of iodine and sodium.

SQM Yodo also plans the construction of another plant in Region I and two at Pinto in Region II. SQM reported that the expansion will allow it to offer iodine manufactured under the strictest U.S. and European pharmaceutical industry standards by using two Chilean patents that it obtained for the product's commercialization. The company also reported that as a result of the expansion, it expected to produce about 8,000 t of iodine in 1997 with the extraction of caliche ore at Pampa Blanca, Coya Norte, and Pampa Toco deposits

Sulfur.—Chile has been an importer and producer of sulfur for many years. In 1997, most sulfur was imported from Bolivia, Canada, and the United States. Consumption of sulfuric acid amounted to 900,000 t/yr. Sulfur obtained from Chilean production, including that derived from smelters and oil refineries, and from importation was used as raw material to produce sulfuric acid in various industrial plants in Regions I through VIII. About 94% of the acid was used in mining and metallurgy, and the balance was applied mainly as a fungicide. Condesa Mining Corp. of the United States received authorization from the Chilean Foreign Investment Committee to carry out a \$25 million development of two sulfur mines near San Pedro de Atacama each with the capacity to treat 1,000 t/yr. The project will include construction of a concentrating plant, a refining plant, and a pipeline to Coloso. No startup date was reported.

As part of a \$323 million investment to reduce sulfur dioxide emissions by one-third, CODELCO's Chuquicamata Division added a new 620,000-t/yr acid plant (No. 4) to replace the 180,000-t/yr plant (No. 1), for a total production of 1.3 Mt. Meanwhile, Refimet will produce 90,000 t/yr of acid in its new copper smelter. Refimet and Escondida signed a contract to smelt 160,000 t/yr of Escondida's copper concentrate. This agreement will significantly increase the volume of copper concentrate from Escondida that would be processed in local smelters. It will also facilitate the expansion of Refimet's installations, which will include the construction of a second sulfuric acid plant and other measures to reduce environmental contamination by eliminating emissions of sulfuric gases. The 10-year contract began in 1996 and, at 1997 price levels, represented a transaction of about \$200 million per year. Startup of new sulfuric acid plants that will use gases from the smelters will increase CODELCO's production by more than 1.8 Mt/yr. As a result, Chile could significantly lower sulfur imports.

Sulfuric acid also was produced from gases from four copper

smelters—Chagres, Chuquicamata, Las Ventanas, and Paipote. These plants had a total production capacity of 2.0 Mt/yr, of which 1.3 Mt/yr was from Chuquicamata; 330 t/yr, from Chagres; 290,000 t/yr, from Las Ventanas; and 60,000 t/yr, from Paipote. Also, about 20 smaller sulfuric acid plants between Arica and Rancagua were using sulfur as raw material. The capacity of these plants totaled about 500,000 t/yr.

Mineral Fuels

Mineral Fuels and Coal.—In 1997, bituminous coal output was reported to be 1.4 Mt. The Chilean Government encouraged greater domestic coal production as a means of reducing the dependence on petroleum. With a population of more than 13.7 million, Chile had a small coal market; the most important consumers were electric utilities. Demand for electricity was concentrated in the central part of the country where 93% of the population lived and in the northern area associated with mining and minerals refineries. The largest coal producer in Chile was Cía. de Carbones de Chile S.A. (COCAR), which strip-mined subbituminous coal in Pecket, near Punta Arenas. In 1997 production from the Pecket Mine was 1.2 Mt/yr. COCAR had a long-term contract with CODELCO to supply CODELCO's Tocopilla powerplant with 850,000 t/yr. Tocopilla, however was, taking all Pecket's output. Potential power station projects for later in this decade included 150-megawatt (MW) plants at Huasco and Tocopilla and a 400-MW facility in the north of the country. Because these could increase total coal demand to 4.5 Mt/yr by the end of the 1990's, COCAR was examining a number of options. Pecket could be expanded by moving into an underground operation, and in prefeasibility studies, was the possibility of development of an additional 100 Mt of reserves at Pecket for an output of 1Mt/yr has explored. COCAR would have to double its capacity to supply the additional demand for that output level. The second possibility was to develop the Isla Riesco Coal project, which would be an open-pit mine, about 40 km from Pecket.

Bituminous coal was found in underground deposits in Region VIII. Operations were carried out in this area by ENACAR, producing around 500,000 t/yr, and Carbonífera Schwager S.A., contributing 340,000 t/yr.

The shareholders of ENACAR approved an increase in the company's capital of \$62.5 million, which will be financed with an issue of more than 3.8 million shares. ENACAR stated that the increase will finance expansion and improvement of operations and that the new infusion of capital will finance the company's debt. The company received financing not only through stocks, but also directly from the Government. The continued capital flow from the state was, however, conditional. The company proved the existence of 2.5 Mt of coal at the end of 1996.

Natural Gas.—The principal natural gas reserves of the country are in the Magallanes Basin in the far south of Chile. Natural gas production decreased to 3.2 billion cubic meters, continuing the declining trend that began in 1990. Of the total production, about 45% was reinjected, and 52% was marketed internally. In the past, the natural gas that was reinjected in the Straits of Magellan Region XII by ENAP which was used to

produce 150,000 t/yr of ammonia and 570,000 t/yr of urea at Cabo Negro.

Construction was expected to begin in mid-1997 on the Atacama pipeline, which will transport natural gas across the Andes Mountains from Salta, Argentina, to the port of Mejillones, Chile, about 56 km north of Antofagasta. The pipeline will have an initial capacity of 3 million cubic meters per day (Mm³/d), eventually rising to 6 Mm³/d. As part of the Atacama project, a 400-MW natural-gas-fired combined-cycle generating plant will be constructed at the end of the pipeline in Chile. The \$700 million integrated power project and pipeline should be operational by 1999. The \$350 million Gas del Sur pipeline would run from the Neuquén gasfields in southern Argentina to Chile's industrial city, Concepción.

Officials of Comisión Nacional de Energía (CNE), indicated that in 1997, efforts will be directed toward the approval of the geothermal energy law and the passage of a bill to modify the Gas Law by establishing regulations for the pipeline transportation of liquid hydrocarbons. CNE carried out studies of the progress of gas pipeline projects, indicating that the Gas Andes project was the most advanced and was expected to be operational in May 1997. The Gas Andes and the Gaseoducto Transandino/Gas de Chile (Trans Gas) consortiums are planning to import natural gas from the Neuquén area; the Gas Andes, across the Andes near Santiago, and the Trans Gas, near Concepción.

Petroleum.—In 1997, Chilean production of crude oil decreased by 8.2%, to 3.1 million barrels (Mbbbl). Chile must import increasing quantities of oil and gas to satisfy its robust growth. In the past 10 years, oil demand has doubled while production has declined by two thirds. As a result, the nation must import most of its oil, 60% of which came from Argentina. In 1997, ENAP signed a contract with the oil workers' union. The agreement now awaits governmental approval. Imports of crude oil in 1997 were 57.3 Mbbbl compared with 53.3 Mbbbl in 1996. The new 105,000-barrel-per-day (bbl/d), 450-km oil pipeline from the Argentine Province of Neuquén to Chilean port of San Vicente on the Pacific Ocean, which was to have opened in early 1997, was delayed for several weeks because of environmental concerns.

The most important private infrastructure project so far in the Southern Cone region of South America is the oil pipeline that would provide Chile with more than two-thirds of its import needs and also set the stage for much wider energy integration in the Region XII. A \$220 million pipeline was built by Oleoducto Transandino S.A., a company formed by ENAP and Argentina's Yacimientos Petrolíferos Fiscales (YPF) and Banco Río de La Plata. YPF held 57.75% of the shares; Banco Río de La Plata, 30%; and ENAP, the balance. Scheduled to be completed in 1997, the pipeline would transport crude oil from Argentina's Puesto Hernández oilfields to Chile's terminal in Talcahuano. Plans called for about 94,000 bbl/d of petroleum to be pumped into the refinery terminal owned by Petrox S.A. Refinería de Petróleo-Chile (Petrox). Petrox was expected to process 37,700 bbl/d, and the remainder was to be shipped from San Vicente to the Concón refinery. ENAP transferred more than \$200 million to the Government during 1997. ENAP profits during this period totaled more than \$125 million after accounting for the 40% tax that was imposed on ENAP because it exploited a nonrenewable

resource.

Reserves

In 1997, CODELCO held more than 8,700 million tons of copper reserves with an average grade of about 0.9% Cu; this was the equivalent of more than 76 years of production at 1997 levels and represented about 20% of global reserves. Confirmed copper reserves at El Abra deposit are 669 Mt of copper oxide with an average content of 0.6% copper and 523 Mt of copper sulfide grading 0.6% copper.

Some of the private sector's reported copper reserves, listed as estimated figures and average grades, were as follows: Escondida, 1,800 million tons, at 1.6% copper; Cerro Colorado, 105 Mt, at 1.3% copper; Quebrada Blanca, 85 Mt at 1.3% copper and 250 Mt at 0.5% copper; and Zaldívar, 316 Mt at 0.9% copper and 680 Mt at 0.6% copper. Collahuasi had three areas with the following reserves and grades: Rosario, 800 Mt at 0.8% copper and 0.25 Mt at 1.7% copper; Ujina, more than 500 Mt at 0.8% copper and 200 Mt at 1.6% copper; and Huinquintipa, 7 Mt at 1.2% oxide copper. La Candelaria reported more than 360 Mt of ore reserves grading 1.09% copper and 0.25 g/t of gold; Andacollo, more than 25 Mt grading 1.3 g/t of gold and 250 Mt grading 0.6% copper; Manto Verde, 93 Mt grading 0.82% copper; and El Refugio, 112 Mt grading 1 g/t of gold and containing about 90 t of gold. According to latest studies, Barrick's El Indio gold deposit has reserves that are greater than originally estimated—about 274 t of gold. El Can Can deposit had proven reserves of 1.2 Mt grading 8 g/t of gold and 60 g/t of silver. Potentially the resources could, however, reach 5.5 Mt of ore. Los Colorados iron ore deposit contained some 245 Mt of minable ore, forming the basis for a 20-year project life and feeding CAP's 4-Mt/yr pellet plant.

Infrastructure

Chile had 9,000-km railway system. The Empresa de Ferrocarriles del Estado (EFE) was the largest government-owned railway. In the past 10 years, almost no investment was made in the railways. The Chilean Government attempted to improve efficiency by investing in infrastructure and rolling stock to expand operational capacity, but EFE continued to deteriorate. Congress approved privatization as the only solution to the huge investments required for rehabilitation. In December 1995, the Government announced, that it would privatize the railroad system, including infrastructure, maintenance and operations. According to the Government's plan, a new operational passenger railroad system from Santiago, to Puerto Montt in the south would be in place by 2000. On May 21, 1997 the President of Chile confirmed that the privatization of the freight railroad had been completed and that the Government was ready to start privatizing the passenger railroad system, including infrastructure, maintenance, and operations. The railway system served all the important industrial, mining, and agricultural areas from Region I (Iquique) to Region X (Puerto Montt) (U.S. Embassy, Santiago, Chile, 1999).

The pattern of highways was similar to that of the railways. The road system totaled 79,750 km, of which 11,006 km was paved; most of the remainder was of secondary quality. The country had 390 airports with paved runways more than 3,000 m long.

International trade of mineral commodities, chiefly copper and its byproducts, was handled through the ports of Antofagasta, Arica, Chanaral, Coquimbo, Iquique, San Antonio, San Vicente, Talcahuano, and Valparaíso; they handled almost 60% of the total tonnage.

Crude oil, refined products, and natural gas were transported to consumption centers by 785-, 755-, and 320-km pipelines, respectively. In addition, a 450-km, 41-centimeter-diameter oil pipeline was expected to transport crude oil from Argentina's Puesto Hernandez oilfields to Chile's Talcahuano terminal in the near future, and a 1,200-km natural gas pipeline between the Neuquén gasfields and Santiago was planned.

Outlook

Chile and Canada signed a bilateral free trade agreement that will eliminate tariffs on most of the \$500 million in goods traded between the two nations when it begins in June 1998. Agreement included no safeguards against predatory pricing and also paved the way for possible expansion of the much larger NAFTA covering Canada, Mexico, and the United States. This was a solid stepping stone for getting Chile into NAFTA.

On October 1, 1998, Chile became an associated member of MERCOSUR, Chile, however, maintained its common external tariff of 11%, MERCOSUR had an average external tariff of 13%.

Chilean mining activities were concentrated in the following mineral groups: coal, copper and its byproducts; industrial minerals; iron and steel; and precious metals. Chile's copper production was expected to grow from 3.4 Mt/yr in 1997 to about 4.4 Mt/yr by 2000, an increase of more than 29%, representing more than 39% of the world supply. Gold was projected to increase from about 49,459 kg in 1997 to 50,000 kg by 1998, representing an increase of nearly 1.1%; and silver was projected to increase from 1.09 Mkg in 1997 to about 1.10 Mkg by 1998, representing an increase of less than 1%.

Production of industrial minerals increased by significant amounts. (See table 1). SQM emerged as a large integrated producer of natural nitrates and distributor of industrial chemicals, iodine and iodine derivatives, lithium carbonate, and specialty fertilizers. In 1997, the company's sales increased by 15.7%, reaching about \$474 million. The production of bentonite, boric acid, diatomite, nitrates, potassium chloride, potassium sulfate, and sulfuric acid were also expected to increase by significant amounts in 1998.

In the energy sector, coal production decreased to 1.41 Mt in 1997 from 1.44 Mt in 1996. The Pecket coal mining project and the Isla Riesco projects in the Otway inlet north of Punta Arenas Region XII, were expected to save Chile about \$40 million in energy costs and an additional \$100 million in oil imports, respectively.

In a report released in May 1997, by SERNAGEOMIN estimated that mineral exploration will increase at an average annual rate of 15% until the end of the decade as Chile's mineral potential continues to be recognized locally and overseas. Exploration expenditures rose by more than 13% in 1996 to about \$178 million of the total exploration expenditure, \$89 million was invested in the search for copper and \$85.4 million for gold. The SERNAGEOMIN report noted that 52% of the exploration investment came from 22 Canadian mining companies, 14% from European companies; 13%, from 6 U.S. companies; 12%, from 8

Chilean companies; and 9%, from 7 Australian companies. More than \$2 billion in new foreign investment projected to be spent in Chile in the near future will add to its reputation as one of the most active mining countries in the world.

References Cited

- Corporación Nacional del Cobre de Chile, 1997, *Memoria Anual*: Santiago, Chile, p. 24-52.
- U.S. Embassy, Santiago, Chile, [1999], *Chile—Fiscal year 1998*: U.S. Embassy, Santiago, Chile, *Country Commercial Guide*, unpaginated.
- Mining Journal, 1998, *Central and South America*: Mining Journal, v. 331, no. 8493, p. 7.
- 1998a, *Supplemental to Mining Journal*: Mining Journal, v. 331, no. 8493, p. 10.
- Weekly Mining News, 1996a, *Candelaria's production expected to fall by 6 percent*: Weekly Mining News, ed. 109, November 27-December 3, p. 2.
- 1996b, *Collahuasi moves forward*: Weekly Mining News, ed. 111, December 11-17, p. 4.
- 1996c, *Exxon to expand Los Bronces*: Weekly Mining News, ed. 107, November 13-19, p. 2.
- 1996d, *Zaldivar set to decide on flotation plant*: Weekly Mining News, ed. 107, November 13-19, p. 4.
- 1997, *Escondida's 1996 production up 80 percent*: Weekly Mining News, ed. 117, January 22-28, p. 3.

Major Sources of Information

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Major Publications

- COCHILCO: *Estadísticas del Cobre y otros Minerales*.
CODELCO: *Annual Report*.
SERNAGEOMIN: *Anuario de la Minería de Chile*.

TABLE 1
CHILE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1993	1994	1995	1996	1997	
METALS						
Arsenic trioxide e/	6,200	4,050	4,076 3/	8,000	8,350 3/	
Copper:						
Mine output, Cu content 4/	thousand tons	2,055	2,220	2,489	3,116	3,392
Metal:						
Smelter, primary 5/	do.	1,205	1,235	1,294	1,356	1,389
Refined: 6/						
Fire-refined, primary	do.	155	201	373	636	881
Electrolytic	do.	1,113	1,076	1,119	1,113	1,236
Total	do.	1,268	1,277	1,492	1,749	2,117
Gold, mine output, Au content	kilograms	33,600	38,786	44,585	53,174	49,459
Iron and steel:						
Iron ore and concentrate:						
Gross weight	thousand tons	7,010	8,341	8,432	9,082	8,738
Fe content	do.	4,390	5,167	5,233	5,275	5,075
Metal:						
Pig iron	do.	917	886	855	850 e/	860 e/
Ferroalloys:						
Ferchromium		680	1,579	2,730	2,700 e/	2,750 e/
Ferromanganese		8,916	8,500	7,987	8,500 e/	8,550 e/
Ferromolybdenum e/		2,202 3/	2,300	2,300	2,300	2,350
Ferrosilicomanganese		1,612	995	1,617	1,600 e/	1,650 e/
Ferrosilicon e/		7,550 3/	5,600	5,600	5,500	5,550
Total		20,960	18,974	20,234	20,600 e/	20,850 e/
Steel, crude 7/	thousand tons	1,069	1,041	1,018	1,135	1,150 e/
Semimanufactures	do.	816	742	866	985	990 e/
Lead, mine output, Pb content		344	1,008	944	1,374	1,264
Manganese ore and concentrate:						
Gross weight		63,000 e/	62,870	70,449	62,887	63,673
Mn content		18,771	18,175	20,188	18,630	18,860
Molybdenum:						
Mine output, Mo content		14,900	15,949	17,889	17,415	21,339
Oxides		10,500 e/	7,980	9,672	17,523 3/	19,291
Rhenium, mine output, Re content	kilograms	6,400 e/	1,479	2,628	2,600 e/	2,500 e/
Selenium e/	do.	49,500	43,000 3/	51,000	50,000	49,500
Silver		970	983	1,041	1,047	1,091
Zinc, mine output, Zn content		29,435	31,038	35,403	36,004	33,934
INDUSTRIAL MINERALS						
Barite		2,035	3,670	3,080	2,559	2,654
Bentonite		989	1,213	684	1,191	717
Borates, crude, natural (ulexite)		117,072	85,935	211,312	149,008	170,605
Cement, hydraulic	thousand tons	3,021	2,995	3,275	3,634	3,735
Calcite (chalk)		5,650	6,300	6,300 e/	6,300 e/	6,200 e/
Clays						
Kaolin		66,939	73,081	10,845	13,452	14,238
Other (unspecified)		17,000	37,553	28,725	18,462	14,537
Diatomite		5,774	10,129	11,451	11,592	11,825
Dolomite		--	4,729	4,631	2,569	11,840
Feldspar		4,150	9,967	7,293	3,702	3,808
Gypsum:						
Crude	thousand tons	511	552	464	520	398
Calcined	do.	190	201	203	200 e/	200 e/
Iodine, elemental		5,958	5,644	5,444	5,514 r/	7,154
Lapis lazuli	kilograms	250	218	190	150	118
Lime, hydraulic	thousand tons	1,300	1,300	1,006	1,050	1,000 e/
Lithium carbonate		10,369	10,439	12,943	14,180	24,246
Nitrogen, natural crude nitrates: e/						
Sodium (NaNO ₃)	thousand tons	707 r/ 3/	673 r/	732 r/	662 r/ 3/	693 r/
Potassium (KNO ₃)	do.	157 r/ 3/	149	163 r/	147 r/	154
Total	do.	864 r/ 3/	822 r/	895 r/	809 r/ 3/	847 r/

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity 2/	1993	1994	1995	1996	1997
INDUSTRIAL MINERALS--Continued					
Phosphate rock (apatite)	14,560	9,975	12,164	17,356	12,605
Pigments, mineral, natural, Iron oxide	7,106	3,283	16,451	18,821	10,768 r/
Potash, K ₂ O equivalent	55,000	50,000	52,100 e/	180,000 e/	150,000 e/
Potassium chloride (KCl)	60,000 e/	83,026	84,290	80,000 e/	80,000 e/
Pumice (includes pozzolan) thousand tons	448	452	466	500	491
Quartz, common do.	459	543	598	583	555
Salt, all types do.	1,440	3,178	3,494	4,043	5,488
Sodium compounds, n.e.s.: Sulfate 8/	44,633 r/	43,168	50,718	44,345	64,335
Sand and gravel (silica) e/ thousand tons	300	300	300	300	300
Stone:					
Limestone (calcium carbonate) do.	5,650	6,305	5,912	6,009	5,618
Marble	872	2,376	5,908	401	1,248
Talc	5,058	5,351	4,107	4,276	3,986
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous and lignite thousand tons	1,397 r/	1,222 r/	1,041 r/	1,115 r/	1,413 r/
Coke, coke oven e/ do.	350	350	350	350	350
Gas natural:					
Gross million cubic meters	4,199 r/	4,239 r/	4,199 r/	3,631 r/	3,211
Marketed do.	2,098 r/	2,050 r/	1,860	1,911 r/	1,900 e/
Natural gas liquids:					
Natural gasoline thousand 42-gallon barrels	1,124 r/	1,124 r/	970 r/	1,000 e/	1,100 e/
Liquefied petroleum gas do.	3,256 r/	3,256 r/	2,810 r/	2,800 e/	2,900 e/
Total do.	4,380 r/	4,380 r/	3,780 r/	3,800 e/	4,000 e/
Petroleum:					
Crude do.	5,190	4,491	3,806	3,351	3,076
Refinery products:					
Liquefied petroleum gas do.	6,080 r/	5,078 r/	5,351 r/	3,585 r/	3,918
Gasoline:					
Aviation do.	53	50 e/	50 e/	83 r/	74
Motor do.	14,452 r/	15,901 r/	14,875 r/	15,744 r/	16,491
Jet fuel do.	2,342 r/	2,811 r/	2,900 r/	2,744 r/	3,764
Kerosene do.	2,073 r/	2,081 r/	2,240 r/	2,443 r/	2,108
Distillate fuel oil do.	16,633 r/	19,612 r/	21,203 r/	20,132 r/	20,989
Residual fuel oil do.	9,929 r/	8,870 r/	14,753 r/	9,812 r/	10,590
Unspecified do.	3,982 r/	3,184 r/	1,524 r/	4,715 r/	4,641
Total do.	55,544 r/	57,587 r/	62,896 r/	59,258 r/	62,575

e/ Estimated. r/ Revised.

1/ Table includes data available through February 1998.

2/ In addition to the commodities listed, pyrite was also produced, but available information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Figures are the nonduplicate copper content of ore concentrates, cement copper, slags and minerals, and copper as a byproduct measured at the last stage of processing as reported by Comision Chilena del Cobre. Mine production, in thousand metric tons, reported by Servicio Nacional de Geologia y Minería was as follows: 1993--2,078; 1994--2,234; 1995--2,510; 1996--3,144; and 1997--3,438.

5/ Detailed statistics on electrowinning are now available and reported in metric tons; by the International Copper Study Group Copper Bulletin (January 1996) as follows, metric tons: 1993--83.8; 1994--225.5; 1995--372.5; 1996--635.7; and 1997--881.1.

6/ Figures are total refined copper distributed into two classes according to method of refining, fire-refined and electrolytic, which includes electrowon copper refined in Chile, as reported by the Chilean Copper Commission.

7/ Excludes castings.

8/ Includes, production of natural sodium sulfate and anhydrous sodium sulfate, coproducts of the nitrate industry (salitre).

TABLE 2
CHILE: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity		
Coal (bituminous)	Empresa Nacional del Carbón, S.A. (ENACAR), subsidiary of Corporación de Fomento de la Producción (CORFO) (Government, 40; private, 60%)	Regions VIII, X, and XII	1,300.		
Do.	Carbonífera Schwagner, S.A. (Agencias Universales S.A., 61%; private shareholders, 39%)	Regions X and XII	170.		
Do. (subbituminous coal)	Cía. de Carbones de Chile S.A. (COCAR) [(Cía. de Petroleos de Chile, S.A., 81%; International Finance Corp. (IFC) (U.S.), 10%; and Northern Strip Mining Ltd. (U.S.), 9%]	Region XII Isla Riesco	1,300.		
Copper	Corporación Nacional del Cobre de Chile (CODELCO) (100% Government)	CODELCO Divisions and Mines:			
		Chuquicamata	650.		
		El Teniente	343.		
		Andina	145.		
		Salvador	88.		
		Rodomiro Tomic	4.		
		El Abra (49% CODELCO)	95.		
		Total	1,326.		
		Do.	do.	Smelters:	
				Chuquicamata	460.
		El Teniente	360.		
		El Salvador	140.		
		Total	940.		
Do.	do.	Refineries:			
		Chuquicamata (sulfide)	600.		
		Chuquicamata (oxide)	85.		
		El Salvador	130.		
Do.	do.	SX-EW plants: 1/			
		Chuquicamata (oxide)	130.		
		El Salvador	1.		
		El Teniente	2.		
Do.	do.	Sulfuric acid plants:			
		Chuquicamata (3 plants)	830.		
		El Teniente	30.		
Do.	Empresa Minera de Mantos Blancos S.A. (Anglo-American Corp., 88%; IFC, 12%)	Plant, Mantos Blancos	90.		
Do.	do.	Smelter, Antofagasta	30.		
Do.	do.	SX-EW plant, 1/ Mantos Blancos	20.		
Do.	do.	Sulfuric acid plant, Mantos Blancos (shutdown)	200.		
Do.	Sociedad Contractual Minera El Abra, Cyprus El Abra Corp. Cyprus Amax Minerals Co., 51% and CODELCO-Chile, 49%)	SX-EW, II Region, El Loa Prov. 45 kilometers north of Chuquicamata.	95.		
Copper, gold, silver	Empresa Minera Escondida Ltda. (Broken Hill Proprietary Company Limited of Australia, 57.5%; Rio Tinto Zinc Corp. Plc., 30%; Japan Escondida Corp., 10%; IFC, 2.5%)	Escondida, kilometer 135 camino a Socompa, Antofagasta	800 Cu, 3,000 Au. 2/		
Do.	Empresa Nacional de Minería (ENAMI) (Government, 100%)	Plants:	130 Cu.		
		Matta, Salado and Vallenar in Region III			
		Taltal in Region II			
Do.	do.	Smelters:			
		Las Ventanas	150 Cu.		
		Paipote	80 Cu.		
Do.	do.	Refinery, Las Ventanas	230 Cu.		

See footnotes at end of table.

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

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Copper, gold, silver--Continued:		Empresa Nacional de Minería (ENAMI) (Government, 100%)	SX-EW plants, 1/ Vallenar	20 Cu.
Do.		do.	Sulfuric acid plant, Ventanas	225 Cu.
Do.		Cía. Minera Disputada de Las Condes S.A. [Exxon (U.S.), 87%; ENAMI, 13%]	Mines: Los Bronces El Soldado El Cobre	70 Cu. 60 Cu. 18 Cu.
Do.		do.	Smelter, Chagres	75 Cu.
Do.		do.	Sulfuric acid plant, Chagres	100 Cu.
Do.		do.	SX-EW plant, 1/ Tortolas	300 Cu.
Do		Cia. Contractual Minera Candelaria (Phelps Dodge, 80%)	Mine, 22 kilometers SE of Copiapo	130 Cu.
Do.		Sumitomo Metal Mining (20%)	Tierra Amarilla	2,488 Au. 2/
Gold		Cía. Minera El Indio (Barrick Gold Corp. of Canada, 82.95%)	El Indio, Pascua (Nevada), and El Tambo. Alto Peñuelas, La Serena, Region IV	6,700 Au. /2 45 Cu.
Do.	kilograms	CODELCO (byproduct from copper) (Government, 100%)	Chuquicamata El Teniente, El Salvador and Andina	1,291.
Gold and silver	do.	Minera Contractual CDE El Bronce (51%). Cía. Minera El Bronce de Petorca (49%).	La Gloria 133, Las Condes - Santiago	2,000 Au.
Do.	do.	Cia. Minera Mantos de Oro (Placer Dome 50%, TVX Gold 50%)	Ladera Farellon, and Farellon Bajo, Region III	8,600 Au, 358,000 Ag.
Iodine and nitrates	metric tons	Sociedad Química y Minera de Chile, (SOQUIMICH) SMQ acquired Amax's share in Minsal in 1992	Miraflores No. 222, Santiago Maria Elena, Pedro de Valdivia Plants	7,154 Iodine, 847,000 nitrates.
Iron ore		Cía Minera del Pacífico, S.A., El Algarrobo, Los Colorados Region III and El Romeral Region IV	Pedro Pablo Muñoz 675, La Serena	5,400 Fe.
Iron ore pellets		do.	Minas El Romeral, El Algarrobo, Los Colorados, Planta de Pellet "La Serena"	5,200.
Lead, zinc, gold		Sociedad Contractual Minera El Toqui. Breakwater Resources- Canada	Baquedano 238, Coyhaique, XI Region Doña Rosa (Zn-Au)	500 Zn, 466 Au. 2/
Lithium carbonate		Sociedad Chilena de Litio Ltda. (subsidiary of Cyprus Foote Minerals Co., private 100%)	Hendaya 60, Piso 3, Las Condes, Santiago,	24.
Lithium carbonate and potassium chloride		Sociedad. Minera Salar de Atacama Ltda. (Minsal) subsidiary of Soquimich	Gertrudis Echinique 30 Piso 16, Las Condes Regional Office: Antofagasta	4.2.
Molybdenum (byproduct from copper)		CODELCO (Government, 100%)	Huérfanos 1270, Santiago	14.4.
Natural gas	million cubic feet	ENAP subsidiary of CORFO (Government, 100%)	Ahumada 341, Santiago	4.0.
Petroleum	million barrels	do.	do.	6.5.
Potassium nitrate		do.	Planta María Elena, Iquique Province	250.
Silver	kilograms	CODELCO-Chile (byproduct from copper)	Huérfanos 1270, Santiago	235,000.
Do.	do.	Cía Minera San José, Ltda. El Indio Mine, Barrick Gold Corp. of Canada, 83%)	Barrio Industrial, Alto Panielas, Coquimbo	48,000.
Sodium nitrate		do.	Planta Pedro de Valdivia, Pedro de Valdivia Province	600.
Sodium sulfate		do.	Oficina Antofagasta, Anibal Pinto 3228	70,000.
Steel		Cía. Siderúrgica de Huachipato S.A., CAP subsidiary (private 100%)	Huérfanos 669, Santiago	800.

1/ Solvent-extraction/electrowinning.

2/ Kilograms.

TABLE 3
CHILE--ESTIMATED MAJOR MINERAL INVESTMENTS, 1994-99

(Million dollars)

Region	Project	Commodity	Owner/s	Investment	Startup date
I	Cerro Colorado	Copper	Rio Algom Inc. (Canada)	200	1998
I	Quebrada Blanca (expansion)	do.	Cominco Ltd., Teck Corp. Ltd, Soc. Minera Pudahuel Ltda, Empresa Nacional de Minería de Chile (ENAMI)	373	1998
I	Sta. Ines de Collahuasi	Copper cathodes	Falconbrige Ltd. (Canada) and Minorco Plc. (Luxembourg)	1,760	1998
I	Rodomiro Tomic	Copper	CODELCO	662	1998
II	El Abra	do.	Cyprus-Amax Minerals Co., 51%; Corporación National del Cobre de Chile S.A., 49%	1,800	1997
II	Zaldivar	do.	Placer Dome Ltd., Outokumpu Copper Resources Chile B.V.	600	1995
II	Santa Barbara (expansion)	do.	Mantos Blancos S.A., Anglo American Corp.	160	1996
II	Lomas Bayas	do.	Gibraltar Mines Ltd.	300	1998
II	La Escondida (expansion)	Copper oxides	Broken Hill Proprietary Company Ltd., Rio Tinto Zinc Corp., Japan Escondida Corp., and International Finance Corp.	1,393	1999
II	Yolanda	Nitrates/iodine	KAP Resources Ltd., Yukon Ltd.	89	1997
II	Minsal	Lithium	Sociedad Química y Minera de Chile S.A.	290	1994
II	Ivan-Zar	do.	Rayrock Yellow Knife Resources Inc.	36	1996
II	Fundicion La Negra	Copper	American Barrick, Noranda Inc.	48	1997
II	Refimet (smelter)	do.	Inversiones Mineras del Pacifico, Minera Barrick and Noranda Inc.	100	1999
II	Leonor/El Tesoro	do.	Luksic Group of Chile and Equatorial of Australia	230	2000
II	La Negra	do.	Noranda Inc.	158	2000
II	Tuina	do.	Minera Mahogeny Ltd. Minera Northern	7	(1/)
II	La Candelaria	Copper/gold	Phelps Dodge Corp., Sumitomo Corp., Minorco Services Ltd., and Falconbridge Ltd.	1500	1994
II	Sierra Gorda	Copper	Yuma Gold Mines Ltd.	85	(1/)
II	Atacama Kosan	do.	Cía. Minera Cominor S.A.	130	1998
II	Prucobre	do.	Punta del Cobre S.A.	50	2000
II	Santa Catalina	do.	Minera Santa Catalina S.A. (Chle), Outokumpu of Finland	100	(1/)
III	Manto Verde	do.	Anglo American Corp., Minorco Ltd.	180	1995
III	El Refugio	do.	Amax Gold Refugio Inc., Bema Gold Ltd.	130	1996
III	La Coipa	Gold/silver	Placer Dome Inc, TVX Gold Inc. Cia. Minera Mantos de Oro	400	1994
III	Nevada.	Gold	Cía. Minera San José Inc. (American Barrick)	168	1997
III	Aldebarán	do.	Placer Dome Ltd.	800	1997
III	Chimberos	Silver	do.	20	1999
III	Pascua	Gold	Barrick of Canada	400	(1/)
III	Cerro Casale	do.	Placer Dome Ltd.	792	(1/)
III	Lobo Marte	do.	do.	300	(1/)
III	Los Colorados	Iron ore	Mitsubishi of Japan	100	1998
IV	Los Pelambres (expansion)	Copper	Luksic Group of Chile and Japaneseconsortium led by Mitsubishi Corp, Mitsubishi Materials, Nippon Mining Marubeni, and Mitsui Corp.	1,307	1999
IV	Andacollo Oro	Gold	Andacollo Gold Inc., La Serena Inc.	50	1996
IV	Tambo (expansion)	do.	Cía. Minera San José Inc. (American Barrick)	105	1995
IV	Quebrada de Pascua	do.	Barrick of Canada	300	(1/)
IV	Andacollo Cobre	Copper	ENAMI(Chile),Tungsten Int. Inc. (Canada), Cia. Minera del Pacifico (Chile)	55	1997
XI	Fachinal	Gold/silver	Coeur d'Alene Mines Corp.	85	1996

1/ To be determined.