

# THE MINERAL INDUSTRY OF

# CHILE

By Pablo Velasco

In 1996, Chile continued to be the top producer and exporter of copper, in terms of volume and value, producing 28.7% of the world's mined copper, and 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 \$3.1 billion in foreign investment, \$1.8 billion was in mining.

The strong performance of the copper subsector affected production in the gold, molybdenum, and silver subsectors, which increased at the rates 2.4%, 14.1%, and 7.5%, respectively. Chile was also one of the world's significant producers and exporters of potassium nitrate and sodium nitrate and ranked second after Japan in world production of iodine, first in lithium, and second after the United States in molybdenum and rhenium.

Figures released by the National Institute of Statistics of Chile for 1996 indicated that the gross domestic product increased by 6.8%, to about \$67 billion<sup>1</sup> at current prices. Inflation was 6.6%, and unemployment, 5.9%. Per capita income increased by 6.4%, to about \$4,700.

Mining officials reported that the total investment in the mining sector reached \$1.8 billion, of which \$1 billion was direct foreign investment channeled through the Foreign Investment Statute Decree Law 600. Corporación Nacional del Cobre de Chile (CODELCO), the State copper corporation, will invest \$720 million; the Empresa Nacional de Minería (ANAEMIA), the national mining company, \$72 million; and the Empresa Nacional del Petróleo (ENAP), the State petroleum (company), \$185 million.

According to the Chilean Copper Commission (COCHILCO), most of the foreign investment in the mining sector was concentrated during the last 7 years in the 20 projects listed in table 3. Some of these projects were recently initiated; others were already in production or in advanced stages of construction. Mining continued to be the most attractive sector for foreign investment, absorbing about 58% of the total foreign investment in 1996.

## Government Policies and Programs

Argentina and Chile signed two historic protocols permitting cross-border exploration and exploitation by two Canadian mining companies. The protocols, which are specific to two mining projects, the Pascua-Lama gold deposit [Barrick Gold

Corp. of Canada (Barrick)] and El Pachón copper project, [Cambior Chile S.A. (Cambior)] still must be ratified by each country's legislature. Argentina's Under Secretary of Mining indicated that the bilateral commission that is generating the protocols will convene in March 1997 in Buenos Aires to work on and eventually to sign a comprehensive treaty allowing more mining along the frontier (Weekly Mining News, 1997b).

The attraction of foreign investment to Chile began as a result of the Decree Law 600 of 1974, which served as the most significant guideline for investment. Further attraction was due to 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—the Foreign Investment Statute Decree Law 600 and Chapter XIV of the Compendium of Foreign Exchange Regulations of the Central Bank of Chile. In 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 is based on economic and legal principles found in the Constitution of Chile, economic equality between foreign investors and nationals being the most important. Another 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.

Chile also offers foreign investors political stability, a modern business environment, accelerated depreciation for tax purposes, and 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 is in Chile; 2.5% of the total is 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 mining, service, and industrial. The Central Bank can demand that transactions for export or import, foreign loans, capital, and profit remittance be conducted through the bank.

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<sup>1</sup>Where necessary, values have been converted from Chilean pesos (Ch\$) to U.S. dollars at the rate of Ch\$412.27=US\$1.00, the average exchange rate in 1996.

Although access to local financing by foreign investors is 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 law is applied 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 on March 1, 1994. This law 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 governmental agencies. The commissions oversee developing and coordinating environmental policies and setting up modern tools for the implementation and enforcement of these policies. Regulations implementing the Basic Law were signed by the President on the same day that the Basic Law was enacted. CONAMA has the legal mandate to define Chile's environmental policy, to propose environmental legislation, and to develop and maintain the resources necessary for the administration and enforcement of environmental regulations. CONAMA was represented in the 12 Chilean regions by the COREMA's. Each COREMA was presided over by a Regional Administrator (an appointed official approximately equivalent to a U.S. Governor) and comprised representatives from regional governments, the private sector, and nongovernmental organizations. The COREMA's were charged with the implementation and enforcement of new regulations and, through COREMA regional subsidiaries, authorized pollution prevention and abatement plans and advised the Ministry of Mining on designing environmental policies and the regulations implementing these policies, diagnosing environmental impacts, and developing 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 promulgated two decrees intended to reduce fixed-source air pollution (including 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. It also took some initial steps to contain and reduce eventually air pollution around Santiago.

Decree Law 185 divided Chile into two zones—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, ENAMI installed a sulfur-recovery plant to control sulfur dioxide emissions at its Hernan Videla Lira (Paipote) smelter. During 1995, CONAMA was to determine if ENAMI's Paipote smelter had met its emissions reduction obligations. 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.

At CODELCO's El Teniente Division, the commitment to maintaining productivity while exercising environmental responsibility has become a top priority during the last several years. Two specific objectives were identified by the Division at El Teniente—reducing emissions and monitoring the living conditions of employees and local inhabitants and using the vast amount of waste water from mine tailings (Weekly Mining News, 1996a) El Teniente Division announced a three-stage plan that will involve the construction of three sulfuric acid plants, the installation of four additional environmental monitoring stations, a community action plan involving the study of the environmental impact of pollutants on mine employees and their families, and an upgrade of the environmental control measures currently in use. 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. Early in 1996, CODELCO had 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 completed, the plant will have the capability to neutralize 36% of the sulfur and 49% of the arsenic currently found in the gas emission from the Caletones smelter (Weekly Mining News, 1996b). The second and third acid plants will make sure that the Caletones smelter complies completely with the environmental measures demanded by the Decree Law 185. In total, arsenic and anhydrous sulfur emissions will be reduced by 97%, and 98% respectively, and 99% of all particulate material matter released by the smelter will be captured (Weekly Mining News, 1996c).

In 1996, 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 Caren. The reservoir is fed by a number of drainage channels that take the water from the mine to the tailings dam (Weekly Mining News, 1996d).

Minera Escondida Ltda.'s (Escondida) operations west of Antofagasta was 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, Minera 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.

## Production

COCHILCO reported that Chilean copper production in 1996 increased by 25%, to 3.12 million metric tons per year (Mt/yr) compared with that of 1995; 1.22 Mt/yr was contributed by CODELCO, or about 61% of the total, and the remainder (39%) by the private sector. The National Mining and Geology Service, an agency of the Ministry of Mines, reported another record high of gold production for Chile in 1996 increasing by 19%, to 53,174 kilograms (kg) and silver production increased by 0.6%, to 1,047,000 kg in 1996. The medium- and small-sized mines produced 95% of the gold and 50% of the silver in the country, followed by the large-sized mines of CODELCO, with 5% of the gold and 50% of the silver produced primarily as byproducts of the copper operation.

CODELCO also accounted for all the output of molybdenum in the forms of molybdenum trioxide and concentrate and was a major sulfuric acid producer. Its molybdenum production reached 17,415 metric tons (t) in 1996, making CODELCO the world's second most important producer after the United States.

The increase in production of copper by the private sector in 1996 established a new benchmark in Chile's historical copper output chiefly because of the startup of five new copper mine projects—La Candelaria, Cerro Colorado, Ivan-Zar, Quebrada Blanca, and Zaldívar—and the increase in output of the expanded La Escondida and El Indio Mines and the second phase of the copper cathode production from the Minera Michilla project. Beginning in 1995 with the addition of several new copper and gold mining projects, the output of copper cathodes had increased to about 20% in 1996 to about 400,000 t/yr, making Chilean mining highly competitive in the world economy. Production of industrial minerals increased significantly compared with that of 1995. (See table 1.)

## Trade

In 1996, Chile's total exports amounted to \$15.4 billion, a decrease of 5.2% compared with that of 1995. The Central Bank of Chile announced that total value of exports in 1996 almost doubled those of 1990, when they were about \$8.4 billion. According to the Bank, mining led the Chilean exporting sector, which totaled a record \$6.3 billion. Mining shipments represented 40.6% of Chile's total exports and a decrease of 10.9% compared with those of 1995. Copper, which was Chile's main export, was worth \$5.8 billion in 1996 or about 38% of the total exports. The decrease in revenues was due mainly to the decrease in the average price per pound of copper from \$1.36 in 1995 to \$1.04 in 1995 which was maintained throughout the year. 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. CODELCO shipped 1.10 million metric tons (Mt) of fine copper in 1996, 0.9% more than was shipped in 1995.

Revenues from copper sales by CODELCO were about \$2.4 billion, or \$659 million less than those of 1995. The most significant byproduct was molybdenum, sales of which amounted to \$25.6 million for shipments totaling 2,590 t fine content. Doré metal, silver, selenium, molybdenum oxide and others were valued at \$316 million.

## 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); 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 Servicio Nacional de Geología y Minería (SERNAGEOMIN), COCHILCO, the Foreign Investment Committee, and CONAMA.

CODELCO, the largest copper producer and exporter in the world, comprised four divisions—Andina, Chuquicamata, El Teniente, and El Salvador—which accounted for 38.8% of all Chilean copper production in 1996. CODELCO was also a producer of gold, metal doré, molybdenum (trioxide, concentrate), rhenium, and silver, as well as ammonium perrenate (rhenium) and sulfuric acid.

ENAMI was created in the early 1960's to promote mining activities, to process and market copper and other minerals, and to provide services to the mining industry. To strengthen this part of its mission, ENAMI established the promotion, development, and processing of Chile's small-and medium-sized nonferrous metals mines output. It also purchased concentrates of copper, gold, and silver; precipitate and minerals for direct smelting; and anodes and blister for its smelters and refineries. ENAMI 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 miners. Furthermore, 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 1996, the total labor force in Chile was about 5 million people. Of that number, the mineral industry employed about 60,000 (including staff and office personnel working directly for the minerals sector), or 1.2%. The metal sector employed about 51,000 workers (including 48,700 copper, gold, and silver miners) or about 85% of the mineral industry total; the industrial minerals sector, employed 3,142, or 5%; the mineral fuel sector

employed 5,635 (including almost 3,400 coal miners), or 9%. CODELCO employed about 35,300 people (including its own copper workers and contractors' personnel), or about 59%.

## Commodity Review

### Metals

**Copper.**—Chile's increased copper production in 1996 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 3.12 Mt of copper, or 25% from that of 1995. The increase in production was due to increased output from the medium-sized mining sector, which accounted for 60.5% of the total. An important aspect of the mining boom is the emergence of solvent extraction and electrowinning (SX-EW) for the low-cost recovery of refined copper. SX/EW production is forecast to increase fourfold over 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; this could have serious implications for the production cost curve.

CODELCO increased its copper output by 39%, to 1.22 Mt, compared with that of 1995, generating a return of more than \$1.1 billion. Of particular note was the startup of El Abra, 6 months ahead of schedule and within budget. El Abra is a high-altitude mine that began commercial production in December 1996. Total investment in the project, a joint venture with Cyprus Amax Minerals of the United States, is \$1.8 billion. The project, owned by Cyprus Amax (51%) and CODELCO (49%), is the world's largest copper heap-leach operation with 1997 production forecast to be 225,000 t at a cash cost of just \$0.35 per pound.

ENAMI has also entered into a number of joint-venture agreements with overseas companies, including Cominco Ltd. of Canada, Cía. Minera Quebrada Blanca S.A. (Quebrada Blanca), and Teck Resources International, Ltd. ENAMI also operated two smelters at Paipote and Ventanas, and the company has obtained a syndicated loan of \$70 million to finance the modernization of these facilities.

The presence of Falconbridge Ltd. (Falconbridge) of Toronto, Canada, in Chile was highlighted by its 50% ownership of Compañía Minera Doña Inés de Collahuasi in the north. This 3,100-Mt project, with an average grade of 0.82% copper, is the largest undeveloped copper mine (Collahuasi Mine) in the world and is slated for production by January 1999. Minorco Plc. of Canada (Minorco) holds the remaining 50% in this \$1.76 billion project (Mining Annual Review, 1997).

Currently, the largest copper mine in the world in terms of production, 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%) is 3,100 meters (m) above sea level in the middle of the Atacama Desert. Proven and probable reserves total more than 2,070 Mt at an average grade of 1.28% copper, sufficient for a mine life in excess of 40 years. Escondida's total annual

production reached 841,000 t of fine copper, an increase of 80% from the 467,000 t produced during 1995 (Weekly Mining News, 1997a).

The copper smelter Refinadora Metalúrgica (Refimet) will be supplying CODELCO's Chuquicamata Division with about 100,000 metric tons per year (t/yr) of copper anode next year under a long-term contract signed at yearend. The contract is the result of Refimet's \$70 million planned expansion to between 150,000 and 160,000 t/yr of copper anode and 290,000 t/yr of sulfuric acid. In 1994, a new acid plant and oxygen enrichment system was installed and a 24-mold Outokumpu Copper Resources Chile B.V. (Outokumpu) anode wheel with the capacity to produce 83 t/d will be delivered to the plant, located in the outskirts of Antofagasta.

Exxon Coal & Mining Company (ECMC) announced that it is going to invest \$570 million in its expansion of Los Bronces copper mine, located 70 km northeast of Santiago. ECMC plan calls for an 84.6% increase in the production of refined copper from a current level of 130,000 to 240,000 t/yr by 2001. ECMC, a subsidiary of Exxon, a U.S. petroleum company, would like to begin the work in 1998 and estimated that it will take 3 years to complete Los Bronces expansion. It would be operational by 2000 and reach design capacity the following year; there are plans to increase its treatment capacity from 37,000 to 75,000 t/d. ECMC will also purchase new equipment for extraction of the mineral. To date, investment in the project has been \$1.2 billion since 1978 when ECMC acquired the deposit and began the series of expansions. The last of these, which began in 1992 and has cost \$440 million, enabled a tripling of production to reach its current level (Weekly Mining News, 1996c).

Empresa Minera Mantos Blancos, S.A. (Mantos Blancos), the new Manto Verde SX-EW project 85 km southeast of the port of Chañaral, was using seawater leaching of 5.4 Mt of 0.9% copper oxide ore from an open-pit mine and will produce 53,500 t/yr of copper cathodes. The huge copper project Doña Inés de Collahuasi (Collahuasi) owned 50-50 owned by Falconbridge and Minorco have put an enormous amount of effort into both the exploration and feasibility stage, which has been approved by both boards. The Collahuasi project consists of two deposits, Ujina and Rosario, which total more than 100 Mt at an average 2% copper and would be processed through a heap-leaching and SX-EW plant with startup slated for 1998. Both companies are making the commitment to proceed with this project toward the 1998 startup of operations. According to Collahuasi's general manager, engineering was 50% ahead of schedule, and the project should produce its first copper cathodes by August 1998. Falconbridge and Minorco, announced a deal in late December to sell 12% of Collahuasi in Chile's Region I, 200 km southeast of the city of Iquique, to a consortium of Japanese smelters in return for a long-term smelting contract. Mitsui & Co., Nippon Mining & Metals Co., and Mitsui Mining & Smelting Co. have agreed to take a 12% equity stake in Collahuasi in return for a long-term contract to buy 250,000 t/yr of copper concentrate. Mitsui & Co. also agreed to provide \$200 million in customer financing, while the consortium also shares project expenses and pays a \$6.8 million

premium on the smelting contract. Falconbridge and Minorco will see their equal 50% stakes in Collahuasi drop to 44% each after the deal closes. The \$1.75 billion Collahuasi is expected to produce 380,000 t/yr of copper (Weekly Mining News, 1996b). The Santa Bárbara and the Manto Verde SX-EW copper operations in Chile, owned by Mantos Blancos, are now operating following the go-ahead by the company late in 1995. Santa Bárbara is an expansion of an open-pit mine operated by Mantos Blancos 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 has also extended the mine's life to 2010. Production should continue at current levels of around 77,400 t/yr, of which 46,000 t/yr will be in the form of copper in concentrates until the middle of the next decade. The new SX-EW circuit produced 2,633 t of copper cathode in December, its first full month of operation. The old smelter at Mantos Blancos is being dismantled. At Manto Verde, the new SX-EW plant has produced some 570 t of cathode; output in the first year of operation was projected to be 30,000 t. Manto Verde is an open-pit, 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, Mantos Blancos sold its copper deposit, Lomas Bayas, in Sierra Gorda (Region II), to Gibraltar Mines, a Canadian mining company, for \$19 million.

In 1996, the production of copper concentrate at La Candelaria Mine fell by 6%, compared with 451,000 t in 1995. The mine, owned by United States-based Phelps Dodge (80%) and the Japanese bank Sumitomo (20%), is located in Chile's Region III. La Candelaria will produce 140,000 t of fine copper in 1997, which is due, in part, to a lower grade of copper being extracted. The company is expanding the Tierra Amarilla ore body and hoped to see an increase in production by the end of 1998. When a new production plant is finished, La Candelaria's average output is expected to reach 175,000 t of fine copper. The company is looking for new ways to reduce the cash cost of production and is initiating exploration on their concessions (Weekly Mining News, 1996a).

Quebrada Blanca in northern Chile (Region I), about 170 km southeast of Iquique and at 4,400 m above sea level has suffered from operational problems with the SX/EW processes owing to the altitude. The project represents an investment of \$360 million. The deposit was controlled by Cominco (38.25%), Teck Resources International, Ltd. (29.25%), Sociedad Minera Pudahuel Ltd. (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. Quebrada Blanca produced 68,000 t of copper cathodes in 1996. This figure was in line with company's projections at the beginning of the year 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 Ltd. of Toronto, Canada, announced that it will go ahead with a 65% expansion of Cerro Colorado, its wholly owned copper mine in Chile's Region I. The company said that production would be increased to 220 million pounds of refined copper by 1999, up from the current level of 130 million pounds. The expansion, which will cost about \$198 million, not including interest and working capital, is scheduled to be completed by mid-1998. Cerro Colorado produced finished copper cathodes by using the thin layer leach and SX-EW processes. As a result of new drilling at Cerro Colorado, the company reported an increase in ore reserves to 193 Mt of ore grading 1.08% Cu. The project produced 45,000 t of copper cathodes in 1996. The initial startup investment was \$290 million (Weekly Mining News, 1996d).

The mine started to receive electricity from the Santiago Interconnected Northern Grid supplied by Compañía Eléctrica Tarapacá (Celta). The general manager of Celta said that the 20-year supply contract is worth \$900 million. To honor the contract, Celta had to build 110 km of 220-kilowatt extension line to connect the mine, which is 4,500 m above sea level (Weekly Mining News, 1996c). To date, \$300 million of a planned expenditure of \$1.75 billion has been spent.

Rayrock Yellowknife Resources Inc. of Toronto, Canada, began production of copper cathodes at the Ivan-Zar Mine, 40 km northeast of Antofagasta. The SX-EW project operated at about 50% capacity and was expected to reach its annual production rate of 8,000 t/yr of copper by year-end 1996. The project consisted of 85 square kilometers (km<sup>2</sup>) of mining claims containing two deposits (the Ivan-Zar and the Emperatriz) and 97 km<sup>2</sup> of exploration claims. Copper is produced by using a combination of open-pit and underground mining methods and bacteria-assisted sulfuric acid technology to leach the metal from oxide and sulfide ores. The solution is combined at the electrowinning process to produce a high purity cathode. The total minable reserves at the two deposits amounted to 4.6 Mt of ore averaging 2.5% copper, indicating a minable reserve life of 10 years (Weekly Mining News, 1996f).

The Zaldívar copper mine and leach operation, which started operations in 1995, was owned by Cía. Minera Zaldívar S.A., a 50-50 subsidiary of Placer Dome Inc. of Canada and Outokumpu; the mine is 175 km east of Antofagasta in northern Chile at about 3,000 m above sea level. The open-pit mine has reserves of 425 Mt of ore grading 0.78% copper, which is sufficient for 19 years of production at the planned rates. During its lifetime, Zaldívar is expected to produce 1.9 Mt of copper cathode. The project, which shipped its first electrowon cathode in June 1995, expanded its total production to 85,000 t in 1996, rising to full capacity of 125,000 t/yr by 1997. Minera Zaldívar announced it will make a decision by the middle of December on whether to build a flotation plant to process copper sulfide. If the company gives approval for the project, then it will mean an investment of between \$15 million and \$20 million. Construction would begin in March or April 1997 and take 6 months to complete. The general manager of Zaldívar said that the plant's capacity will range between

10,000 and 15,000 t/yr of copper concentrate. On October, Minera Zaldívar reported that production would fall short of the 85,000-t goal by 10,000 t but 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 (Weekly Mining News, 1996g).

The Luksic Group has signed with Nippon Mining & Metals and four other Japanese firms a letter on intent to take a 40% stake to expand production at Los Pelambres copper mine located at Region IV, 200 km north of Santiago. The Luksic Group will retain a 60% stake in the project. The Japanese investors will be divided into two groups, one consisting of Nippon Mining & Metals (15%), Marubeni Corp. (8.75%), and Mitsui & Co Ltd. (1.25%) and the other consisting of Mitsubishi Materials Corp. (10%) and Mitsubishi Corp. (5%). The contract could be signed as early as January. The proposed expansion will increase production of copper concentrate to 260,000 t/yr by 2000. The current production level of the mine is 23,000 t/yr. The project will require an investment of \$1.04 billion, which will be supplied by the partners in direct proportion to their percentage of ownership, according to the proposed contract (Weekly Mining News, 1997a).

**Gold and Silver.**—Production of gold and silver in 1996 was 53.2 and 1,047 t, respectively; this represented an increase of 19.3% and 10.2% from 1995 production. Most of the gold was produced by the medium-size gold mines (72%). The large-sized mines of CODELCO produced 27% of the gold.

Among the gold-producers in Chile, El Indio Mine remained the largest. It was owned by Barrick, which acquired the property from Lac Minerals Ltd. (LAC Minerals), also of Canada, in 1994. In 1994, Barrick spent about \$500 million to expand El Indio and other gold properties in Chile and spent about \$200 million in 1995 and 1996 on El Indio and El Tambo Mines and finalized the feasibility study of its Pascua Mine (formerly known as Nevada gold project). According to latest studies, El Indio gold deposit holds reserves greater than originally estimated and will allow the company to increase its expected production from 31.1 t/yr and to 62.2 t/yr. The total reserves of gold at El Indio were estimated to be about 273.7 t.

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. The company reported record earnings of \$292.3 million in 1996, a 17% increase over those of 1995, and revenues of \$1.3 billion. Gold production rose from 72.5 to 97.7 t, and operating costs were \$5.7 per gram. Its total gold reserves at yearend were at 1,347 t. Significantly,

Barrick had unwound one-third of its hedge position at the end of 1995; its position was cut to about 2 years of production, or 186.6 t from about 279.9 t, at prices of between \$12 and \$12.30 per gram.

The second largest gold producer in the private sector in Chile was La Coipa Mine, owned by Dayton Development Corp., Placer Dome, and TVX Gold Inc. of Canada. Niugini heap-leach operations contributed 1,700 kg of gold in doré bars. CODELCO maintained its level of output of gold at about 2,500 kg in 1996 as a byproduct of its electrolytic copper refining.

La Coipa Mine was the largest producer of silver in Chile as a byproduct of gold production. La Coipa's silver output in 1996 was about 404,000 kg, 35% of the country's total output. La Coipa, operated by Cía. Minera Mantos de Oro Limitada., was operating at its capacity of 15,000 t/d of ore by yearend 1996. 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) Choquelimpie Mine and plant, El Hueso (Homestake), San Cristóbal (Niugini), La Escondida, El Bronce de Petorca, and El Guanaco project owned by (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.

According to the feasibility study completed by Mineral Resources Development Inc., El Refugio would require an open pit with a stripping ratio of 1 to 1. The study recommended a plant with a processing capacity of 33,000 t/d. At that rate, Bema Gold Company (Bema Gold) could produce 7.2 t/yr of gold for 13 years. Bema Gold may consider bringing a partner onboard to develop its promising Cerro Casale gold deposit in Chile, part of the Aldebarán properties. Because preliminary costs for developing the mine, which could yield as much as 5.4 t/yr of gold, range from \$800 million to \$1 billion, raising this amount of capital might require an investment partner, according to the company president. Alternatively, funds could be raised by selling the 49% of Aldebarán currently held by Arizona Star Resource Corp. in which Bema Gold has a 30% stake. Bema Gold raised gross proceeds of \$88 million in a financing exercise which saw the issue of 8 million common shares in the company. A deep drilling program will take place during the remainder of this year and throughout 1997, working up to a prefeasibility study. Cerro Casale could contain as much as 13.2 t of gold and 113,000 t of copper; although the gold grades are not very high, the mine could be profitable at high-volume production levels. Previous drilling and geophysical testing in this area indicates the potential for the zone to host a large porphyry gold deposit. Bema Gold was also carrying out 2,500 m of reverse circulation drilling on the Quebrada Seca and Marisella porphyry targets on its 100%-owned Quebrada Seca property, 14 km east of Cerro Casale. Cerro is located just 30 km north of Bema Gold's El Refugio gold mine which started production at the beginning of the year (Metal Bulletin,

1996).

**Iron Ore, Manganese, and Steel.**—In 1996, Chilean iron production increased by 7.7% to 9.1 Mt. 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 for the domestic market in Coquimbo plant. The company produced manganese ore at the El Corral Quemado and Los Loros Mine in Region IV; MASA also bought ore from other producers in the same region.

Most of the manganese produced by MASA was bought by the Huachipato smelter. The production of steel ingots at Huachipato amounted to 1.14 Mt, 11.5% higher than that of 1995. 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 (SCMT), is owned by LAC Minerals Ltd. of Canada and is located near Coyhaique in southern Chile. Despite problems resulting from low prices, SCMT produced about 73,000 t of concentrate containing 36,000 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 Coyhaique. Low zinc prices have, however, convinced the company to postpone its plans to expand SCMT.

Production of zinc in Chile increased by 1.7% in 1996, to about 36,000 t, of which 91% was from SCMT. The expansion program carried out by LAC Minerals at SCMT in 1993 was largely responsible for the notable increases in Chilean zinc production in the last 3 years.

## *Industrial Minerals*

**Lithium and Potassium.**—Chile is the second largest producer of lithium in the world after the United States. Production of lithium carbonate was 14,180 t, 9.6% more than that of 1995. 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's subsidiary earnings in 1996 amounted to \$70.2 million, which were 72.4% higher than those of 1995, and consolidated revenues reached \$473.7 million, which were 15.7% higher than the \$409.6 million recorded in 1995. Minsal, extracts the brines from the Salar de Atacama, which it processes to produce potassium chloride and lithium carbonate. During the 1998, SQM will add potassium sulfate and boric acid production. The high concentrations of boron, lithium, magnesium, potassium, and 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. The lithium carbonate plant is scheduled to produce 9,000 t in 1997 and is slated to have a production capacity of 18,000 t/yr as of the third quarter of 1997. SQM is also the world's only producer of specialty fertilizer based on natural nitrates. In 1996, sales reached about \$262.3 million, representing 55.4% of the company's total sales.

**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 solution of salt concentration 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.

To double its production of iodine, SQM started a \$23

million expansion program in Regions I and II. The first phase of SQM expansion program has been completed and SQM intends to startup the expansion of the Florencia nitrate plant, 100 km north of Antofagasta. The plant is expected to produce 1,000 t of iodine in 1996. The program, which was being carried out by the subsidiary of SQM, 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, SQM will increase its nitrate production capacity to about 100,000 t/yr in 1997. Investment in iodine and derivatives during 1996 will allow SQM to reach a production capacity of about 8,000 t/yr by the second half of 1997. Sales in 1996 reached \$91.4 million, which represents 19.3% of overall company income and reflects an increase of 34.5% compared with those of 1995. World iodine production is centered in Chile, Japan, and the United States. SQM produces about 33% of worldwide iodine sales in its plants located in Chile, France, and the United States, thereby consolidating the company's expansion in their markets.

**Sulfur.**—Chile has been an importer and producer of sulfur for many years. In 1996, most sulfur was imported from Bolivia, Canada, and the United States. 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 (6%) 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, with a capacity each to treat 1,000 t/yr near San Pedro de Atacama. 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, 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 Minera 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 contract has a duration of 10 years beginning in 1996 and, at current price levels, represents a transaction of about \$200 million per year. Consumption of sulfuric acid in Chile

amounted to 900,000 t/yr. Startup of new sulfuric acid plants that uses 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 (Hernan Videla Lira). These plants have a production capacity of 2.0 Mt/yr, of which 1.3 Mt/yr was from Chuquicamata; 290,000 t/yr, from Las Ventanas; 60,000 t/yr, from Paipote; and 330 t/yr, from Chagres. 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*

**Coal.**—In 1996, bituminous coal output was estimated to be 1.4 Mt. The Chilean Government has encouraged greater domestic coal production as a means of reducing the dependence on petroleum. Chile, with a population of more than 13.7 million, has a small coal market in which 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. Its current production from the Pecket Mine was 1.2 Mt/yr. COCAR has a long-term contract with CODELCO (expiring in 1997 but expected to be renewed sooner) to supply CODELCO's Tocopilla powerplant with 850,000 t/yr. Tocopilla was, however, 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, has explored the possibility of development of additional 100 Mt of reserves at Pecket for an output of 1 Mt/yr. COCAR would have to double its capacity to supply the additional demand for that output level. The second possibility was to develop the Isla Riesgo deposit, 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 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 receives financing not only through stocks, but also directly from the Government. The continued capital flow from the state is, 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 3.6 billion cubic meters, continuing the declining trend that began in 1990. Of the total production, about 45% was reinjected, and 55% was marketed internally. In the past, the natural gas that was reinjected in the Straits of Magellan Region by ENAP has to be used to produce 150,000 t/yr of ammonia and 570,000 t/yr of urea at Cabo Negro. During 1996, 55% of the natural gas was produced from offshore, 23% from onshore, and 22% from Tierra del Fuego. Construction is 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 (Mm<sup>3</sup>/d), eventually rising to 6 Mm<sup>3</sup>/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. Construction of the pipeline will begin in 1997, and operation, in 1998.

Officials of Comisión Nacional de Energía CNE, stated that in 1997 efforts will be directed at 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 had 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. The CNE officials indicated that the Gas Andes consortium planned to invest \$284 million in this gas pipeline project, of which \$110 million will be invested in Chile. CNE reported that the Trans Gas consortium is at the stage where its gas transport concession has been granted. The investment by this consortium is estimated to be \$689 million, of which \$484 million is to be in Chile. The Gas Sur pipeline project proposal is currently at its "open season" stage.

**Petroleum.**—Chilean production of crude oil sustained a decrease of 12% in 1996 to 3.3 million barrels (Mbbbl). Imports of crude oil in 1996 were 47.7 Mbbbl compared with 43.3 Mbbbl in 1995. The new 105,000-barrel-per-day (bbl/d), 450-km oil pipeline from the Province of Neuquén (Argentina) to the port of San Vicente (Chile) on the Pacific Ocean, which was to have opened in early 1996, was delayed for several weeks for environmental reasons.

The most important private infrastructure project so far in the Southern Cone region of South America is the oil pipeline, which would provide Chile with more than two-thirds of its import needs. The pipeline also set the stage for much wider energy integration in the Southern Cone. 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 1996, 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 Petrox's refinery terminal. 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 1996. ENAP profits during this period reached more than \$120 million after accounting for the 40% tax the group has to pay. This tax is imposed on ENAP because it exploits a nonrenewable resource. In 1997, ENAP will invest close to \$200 million, most of which will be used to improve infrastructure at the Concón and the Talcahuano refineries, as well as in the exploration for crude oil. A ceremony launched "Golden Diesel," a new fuel having a lower sulfur content than previous diesel fuels, that will be used by buses in Santiago; the buses are blamed for much of the pollution in the capital. It is being refined at the Petrox unit.

## Reserves

In 1996, CODELCO held more than 9 billion metric tons of copper reserves with an average grade of about 0.9% Cu; this is the equivalent of more than 69 years of production at present levels and represents 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, 1.8 billion 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 Huiniquinta, 7 Mt at 1.2% oxide copper. La Candelaria reported more than 360 Mt of ore reserves grading 1.09% copper and 0.25 grams per ton (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 containing about 90 t of gold. According to latest studies, Barrick's El Indio gold deposit holds reserves that are greater than originally estimated. The reserves are now reported to be 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. The Colorado 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

The 8,613-km railway system served all the important industrial, mining, and agricultural areas from Region I (Iquique) to Region X (Puerto Montt). 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, Cruz Grande, San Antonio, Talcahuano, Tocopilla, 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. 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 gasfields in Neuquén and Santiago was planned.

## Outlook

In 1996, officials of Canada, Mexico, and the United States were consulting with Chile to keep alive Chile's bid to join the North American Free Trade Agreement in the face of a trade policy impasse in the United States.

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 2.49 Mt/yr in 1996 to about 4.4 Mt/yr by the year 2000, an increase of more than 75%, representing more than 35% of world supply. Gold was projected to increase from about 39,180 kg in 1996 to 43,800 kg by 1997, representing an increase of nearly 12%; and silver was projected to increase from 1,032,000 kg in 1996 to about 1,040,000 kg by 1997, representing an increase of less than 1%.

Production of industrial minerals as shown in table 1 increased by significant amounts. 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 1996, 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 1997.

In the energy sector, coal production declined to 1.4 Mt in 1996 from 1.5 Mt in 1995. The Pecket coal mining project and the Isla Riesco projects in the Otway inlet north of Punta Arenas

are expected to save Chile about \$40 million in energy costs and an additional \$100 million in oil imports.

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.

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## Major Sources of Information

### Ministerio de Minería

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### Servicio Nacional de Geología y Minería (SERNAGEOMIN)

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Santiago, Chile  
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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/	1992	1993	1994	1995	1996
<b>METALS</b>					
Arsenic trioxide e/	6,020 3/	6,200	6,300	6,400	9,000
<b>Copper:</b>					
Mine output, Cu content 4/	1,933	2,055	2,220	2,489 r/	3,116
<b>Metal:</b>					
Smelter, primary 5/	1,160	1,205	1,235 r/	1,294 r/	1,356
Refined: 6/					
Fire-refined, primary	136	155	201	373 r/	636
Electrolytic	1,106	1,113	1,076	1,119 r/	1,113
Total	1,242	1,268	1,277	1,492 r/	1,749
Gold, mine output, Au content	33,800	33,600	38,786	44,585 r/	53,174
<b>Iron and steel:</b>					
<b>Iron ore and concentrate:</b>					
Gross weight	7,640	7,010	8,341 r/	8,432 r/	9,082
Fe content	5,120	4,390	5,167 r/	5,233 r/	5,275
<b>Metal:</b>					
Pig iron	873	917	886 r/	855 r/	850 e/
<b>Ferroalloys:</b>					
Ferrochromium	2,110	680	1,579 r/	2,730 r/	2,700 e/
Ferromanganese	7,460	8,916 r/	8,500 e/	7,987 r/	8,500 e/
Ferromolybdenum	2,310	2,202 r/	2,300 e/	2,300 e/	2,300 e/
Ferrosilicomanganese	1,564 r/	1,612 r/	995 r/	1,617 r/	1,600 e/
Ferrosilicon	3,830	7,550	5,600 e/	5,600 e/	5,500 e/
Total	17,274 r/	20,960	18,974 r/	20,234 r/	20,600 e/
Steel, crude 7/	1,013 r/	1,069 r/	1,041 r/	1,018 r/	1,135
Semimanufactures	776	816	742	866 r/	985
Lead, mine output, Pb content	298	344	1,008 r/	944 r/	1,374
<b>Manganese ore and concentrate:</b>					
Gross weight	49,900	63,000	62,870	70,449 r/	62,887
Mn content	14,915 r/	18,771 r/	18,175 r/	20,188 r/	18,630
<b>Molybdenum:</b>					
Mine output, Mo content	14,500	14,900	15,949 r/	17,889 r/	17,415
Oxides	10,400	10,500 e/	7,980 r/	9,672 r/	9,500 e/
Rhenium, mine output, Re content	6,600 e/	6,400 e/	1,479 r/	2,628 r/	2,600 e/
Selenium e/	50,000	49,500	43,000 r/ 3/	51,000 r/	50,000
Silver	1,030	970	983	1,041 r/	1,047
Zinc, mine output, Zn content	29,730 r/	29,435 r/	31,038 r/	35,403 r/	36,004
<b>INDUSTRIAL MINERALS</b>					
Barite	2,514	2,035	3,670	3,080 r/	2,559
Bentonite	1,081	989	1,213	684 r/	1,191
Borates, crude, natural (ulexite)	202,716	117,072	85,935	211,312 r/	149,008
Cement, hydraulic	2,645 r/	3,021 r/	2,995 r/	3,275 r/	3,400 e/
Calcite (chalk)	4,890	5,650	6,300	6,300 e/	6,300 e/
<b>Clays</b>					
Cimita	405	--	--	--	-- e/
Kaolin	59,083	66,939	73,081	10,845 r/	13,452
Other (unspecified)	20,300	17,000	37,553 r/	28,725 r/	13,462
Diatomite	5,900	5,774	10,129	11,451 r/	11,592
Dolomite	--	--	4,729 r/	4,631 r/	2,569
Feldspar	5,740	4,150	9,967	7,293 r/	3,702
<b>Gypsum:</b>					
Crude	424	511	552	464 r/	520
Calcined	161	190	201	203 r/	200 e/
Iodine, elemental	5,906 r/	5,958 r/	5,644 r/	5,444 r/	6,895
Lapis lazuli	138	250	218 r/	190 r/	150
Lime, hydraulic	1,300	1,300	1,300 r/	1,006 r/ 3/	1,050
Lithium carbonate	10,823	10,369	10,439	12,943 r/	14,180
<b>Nitrogen, natural crude nitrates: e/</b>					
Sodium (NaNO <sub>3</sub> )	515 3/	532	500	500	500
Potassium (KNO <sub>3</sub> )	331 3/	342	300	300	300
Total	846 3/	874	800	800	800

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity 2/	1992	1993	1994	1995	1996
<b>INDUSTRIAL MINERALS--Continued</b>					
Phosphates:					
Guano	139	--	--	--	-- e/
Rock (apatite)	17,546	14,560 r/	9,975 r/	12,164 r/	17,356
Total	17,685 r/	14,560 r/	9,975 r/	12,164 r/	17,356
Pigments, mineral, natural, Iron oxide	22,945 r/	7,106 r/	3,283 r/	16,451 r/	18,821
Potash, K <sub>2</sub> O equivalent e/	55,000	55,000 3/	50,000 3/	52,100 r/	180,000
Potassium chloride (KCL)	58,800	60,000 e/	83,026 r/	84,290 r/	80,000 e/
Pumice (includes pozzolan) thousand tons	385	448	452 r/	466 r/	500
Quartz, common do.	484	459	543 r/	598 r/	583
Salt, all types do.	1,670	1,440	3,178	3,494	4,043
Sodium compounds, n.e.s.: Sulfate 8/	1,333 r/	1,433 r/	1,668 r/	2,488 r/	1,745
Sand and gravel (silica) e/ thousand tons	300	300	300	300	300
Stone:					
Limestone (calcium carbonate) do.	4,890	5,650	6,305	5,912	6,009
Marble	894	872	2,376	5,908	401
Sulfur:					
Native, other than Frasch:					
Refined	24,034	444	--	--	-- e/
Caliche	--	493	--	--	-- e/
Byproduct, (from smelters and oil refining)	306,000	385,000	385,000 r/ e/	360,000 e/	350,000 e/
Total	330,034	385,937	385,000 r/ e/	360,000 e/	350,000 e/
Talc	1,493	5,058	5,351	4,107 r/	4,276
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Coal, bituminous and lignite thousand tons	2,125	1,798	1,667	1,490 r/	1,446
Coke, coke oven e/ do.	300	350	350	350	350
Gas natural:					
Gross million cubic meters	4,038	4,196	4,244	3,783 r/	3,632
Marketed do.	1,999	1,951	2,185	2,185 r/ e/	2,000 e/
Natural gas liquids: e/					
Natural gasoline thousand 42-gallon barrels	690	680	650	640	640
Liquefied petroleum gas do.	2,000	1,970	2,000	2,100	2,100
Total do.	2,690	2,650	2,650	2,740	2,740
Petroleum:					
Crude do.	5,423	5,190	4,491	3,806 r/	3,351
Refinery products:					
Liquefied petroleum gas do.	7,740	7,930	8,000 e/	6,000 e/	7,000 e/
Gasoline:					
Aviation do.	53	53	50 e/	50 e/	50 e/
Motor do.	13,300	13,600	13,400 e/	13,500 e/	13,600 e/
Jet fuel do.	2,380	2,440	2,440 r/ e/	2,450 e/	2,450 e/
Kerosene do.	2,190	2,250	2,300 e/	2,350 e/	2,350 e/
Distillate fuel oil do.	17,900	18,400	18,500 e/	18,450 e/	18,600 e/
Residual fuel oil do.	1,770	1,810	1,800 e/	1,900 e/	1,950 e/
Unspecified do.	2,080	2,120	2,100 e/	2,200 e/	1,500 e/
Total do.	47,413	48,603	48,550 r/ e/	46,900 e/	47,500 e/

e/ Estimated. r/ Revised.

1/ Table includes data available through Dec. 1997.

2/ In addition to the commodities listed, pyrite is 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 reported by Servicio Nacional de Geologia y Minería was as follows, in thousand metric tons: 1992--1,967; 1993--2,078; 1994--2,234; 1995--2,510; and 1996--3,144.

5/ Detailed statistics on electrowinning are now available and reported by the International Copper Study Group Copper Bulletin (Jan. 1996) as follows, in metric tons: 1992--166.6; 1993--183.8; 1994--225.5; 1995--372.5; and 1996--635.7.

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/ Do not include production of natural sodium sulfate and anhydrous sodium sulfate, coproducts of the nitrate industry (salitre).

TABLE 2  
CHILE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(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 XI	1,300.
Do.	Carbonifera 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)	Mines:	
		Chuquicamata	580
		El Teniente	320
		Andina	145
		Salvador	85.
		Total	1,130
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.	Empresa Minera Escondida Ltda. (BHP, 57.5%; RTZ Corp. PLC, 30%; JECO, 10%; IFC, 2.5%)	Escondida, Kilometer 135 camino a Socompa, Antofagasta	800 Cu. 3,300 (Kg, Au).
Copper, gold, and silver	Empresa Nacional de Minería (ENAMI) (100% Government)	Plants:	270.
		Taltal, Salado, Matta, Vallenor Chancado	
Do.	Do.	Smelters:	
		Las Ventanas	145.
		Paipote	80.
Do.	Do.	Refinery:	
		Las Ventanas	200.
Do.	Do.	SX-EW plants: 1/	
		Vallenar, Chancado	20.
Do.	Do.	Sulfuric acid plant:	
		Ventanas	225.
Do.	Exxon's Cía. Minera Disputada de Las Condes, S.A. [Exxon (US), 87%; ENAMI, 13%]	Mines:	
		Las Bronces	70.
		El Soldado	60.
		El Cobre	18.
Do.	Do.	Smelter:	
		Chagres	75.
Do.	Do.	Sulfuric acid plant, Chagres	100.
Do.	Do.	SX-EW plant, 1/ Tortolas	3.

See footnote at end of table

TABLE 2--Continued  
CHILE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Gold	kilograms	Cía. Minera San José, Ltda. (Barrick Gold Corp. of Canada, 83%)	El Indio and El Tambo. Alto Panuelas, Coquimbo	5,900 Au. 2,600 Au.
Do.	do.	CODELCO (byproduct from copper) (Government, 100%)	Chuquicamata El Teniente, El Salvador and Andina	2,200.
Gold and silver	do.	Cía. Minera El Bronce de Petorca (private, 100%)	Carmencita 240, Las Condes Santiago, Chile	52,700 Au.
Iodine	metric tons	Sociedad Química y Minera de Chile, subsidiary of CORFO (private, 65%; Government, 35%)	Miraflores No. 222, Santiago	5,500.
Iron ore		Cía Minera del Pacífico, S.A., CAP's subsidiary (private, 100%)	Pedro Pablo Muñoz 675, La Serena Province	8,400.
Iron ore pellets		Do.	Minas El Romeral, El Algarrobo, Planta de Pellet, La Serena Province	4,000.
Lead and zinc		Soc. Contractural Minera El Toqui Ltda., (LAC Minerals of Canada, 100%)	Las Urbanas No 53, Providencia, Santiago	1.0 lead. 31.0 zinc.
Lithium carbonate		Soc. Chilena de Litio Ltda. (subsidiary of Cyprus Foote Minerals Co. of the United States) (private, 100%)	Huérfanos 669, Santiago	8.6.
Molybdenum (byproduct from copper)		CODELCO (Government, 100%)	Huérfanos 1,270, Santiago	14.4.
Natural gas	million cubic feet	ENAP subsidiary of CORFO (Government, 100%)	Ahumada 341, Santiago	4.
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.

TABLE 3  
CHILE--MAJOR MINERAL INVESTMENTS 1994-97 e/

(Million dollars)

Region	Project	Commodity	Owner/s	Investment	Startup date
I	1. Cerro Colorado	Copper	Rio Algom (Canada)	60	1996
I	2. Quebrada Blanca (expansion)	do.	Cominco, Ltd., and Teck Resources International Ltd. of Canada, Pudahuel and Empresa Nacional de Minería (ENAMI) of Chile.	373	1996
I	3. Collahuasi (Ujina and Rosario)	do.	Falconbridge Ltd. and Minorco Plc. (Canada)	1,760	1997
II	4. El Abra	do.	Cyprus AMAX (U.S.) (51%), Corporación del Cobre de (CODELCO) (Chile) 49%	1,800	1997
II	5. Zaldivar	do.	Outokumpu Copper Resources Chile B.V. (Finland), Placer Dome (Canada)	600	1995
II	6. Leonor	do.	Equatorial Treasure Ltd. (Australia)	100	1997
II	7. Santa Barbara (expansion)	do.	Mantos Blancos S.A. (Chile) and Anglo-American (South Africa)	160	1995
II	8. Lomas Bayas	do.	Gibraltar Mines Ltd. (Canada)	200	1997
II	9. Escondida (expansion)	do.	Broken Hill Proprietary Company Limited (Australia), Rio Tinto Zinc Corp. Plc. (U.K.), Japan Escondida Corp. (Japan), and International Finance Corp. (US)	1,100	1997
II	10. Yolanda	Nitrates/iodine	KAP Resources Ltd. (Canada) and 10224 Yukon Ltd. (Canada)	89	1997
II	11. Minsal	Potassium chloride lithium carbonate	Sociedad Química y Minera de Chile S.A. (SQM)	290	1994
II	12. Ivan-Zar	do.	Rayrock Yellow Knife Resources Inc. (Canada)	36	1996
III	13. Manto Verde	do.	Anglo-American Corp. (South Africa), Minorco and Mantos Blancos subsidiaries	180	1995
III	14. La Candelaria	do.	Phelps Dodge (U.S.), Sumitomo Corp. of Japan, Minorco Services Ltd., Falconbridge Ltd.	1,500	1994
III	15. Refugio	Gold	AMAX Gold Refugio Inc. (U.S.), Bema Gold (Canada)	130	1996
III	16. La Coipa	Gold/silver	Placer Dome (Canada), TVX Mining (Canada)	400	1992
IV	17. Los Pelambres (expansion)	Copper	Luksic Group (Chile)	1,000	NA
IV	18. Andacollo Oro	do.	Andacollo Gold Inc., La Serena Inc. [Dayton Mining Co. (Canada)]	50	1996
IV	19. Nevada.	Gold	Cía. Minera San José Inc.	168	1997
	Tambo (Expansion)	do.	El Indio Property	105	1995
	Quebrada de Pascua	do.	American Barrick (Canada)	300	NA
XI	20. Fachinal	Gold/silver	Coeur d'Alene Mines Corp. (US)	85	1996

e/ Estimated. NA Not available.