

THE MINERAL INDUSTRY OF

CHILE

By Pablo Velasco

In 1998, Chile continued to be the top producer and exporter of copper in terms of volume and value, producing 30.8% 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% was in mining. Direct foreign investment in Chilean mining rose to \$1.6 billion in 1997.

Copper remained the country's most important export product, accounting for about 36% of export earnings in the first 9 months of 1998. 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. Chile ranked first in lithium, second in rhenium, and third in molybdenum. Chile's economy grew by 3.5% in 1998. The gross domestic product (GDP) growth in 1998 was about 5.5%, rising to about \$79 billion at current prices.¹ Inflation and unemployment decreased to 4.7% and 6.4% respectively. Per capita income increased by 1.9%, to about \$5,400 (U.S. Embassy, Santiago, Chile, 1998).

Mining officials reported that the total investment in the mining sector reached \$1.63 billion, which was direct foreign investment channeled through the Foreign Investment Statute Decree Law (DL) 600. Corporación Nacional del Cobre de Chile (CODELCO) invested \$675 million in 1998, 2.3% lower than that of 1997. Of this total, \$291 million was expended in the expansion of the Andina Division.

Mining was central to the Chilean economy. Nitrates provided more than 70% of export earnings early in the 20th century, and copper provided more than 50% of export earnings in the past 30 years. In 1998, mining provided more than 8% of the GDP and 50% of export revenue and continued to be the most attractive sector for foreign investment, absorbing about 56% of the total foreign investment in 1997. In 1997 and 1998, however, half of the total foreign investment in mining was spent in Region I, northern Chile, the bulk of this investment being accounted for by the development of the Collahuasi Mine, which was running ahead of schedule for production in the fourth quarter of 1998 (Mining Journal, 1998a).

Government Policies and Programs

Chile has joined the Asia-Pacific Economic Cooperation Organization in an effort to boost commercial ties to Asian markets. Also, Chile and the European Union (EU) plan to

negotiate a trade agreement in the medium term. Chile shared the U.S. interest in negotiating a comprehensive trade agreement between the two countries. This is because the United States was Chile's most important single trading partner and source of foreign investment. In 1995, Chile began negotiations to join the North American Free Trade Agreement (NAFTA). Those talks have been stalled because of political factors in the United States. The U.S. administration planned to introduce legislation in Congress, which, if approved, would allow negotiations related to Chilean accession to NAFTA or to a bilateral trade agreement with the United States.

A key feature of the government of Chile's development strategy was a welcoming attitude towards foreign investors, which was embodied in the country's foreign investment law, known as DL 600. DL 600 was promulgated in 1974 and has been liberalized through frequent revisions. Under this law, foreign investment must be approved by the Government's Foreign Investment Committee. It served as the most significant guideline for foreign investment. Investors choosing not to use DL 600 may invest via the provisions of Chapter XIV of the Central Bank's foreign exchange regulations. Under Chapter XIV, investors can be required to deposit a certain percentage of the value of capital inflows in a noninterest-bearing central bank account (known as the "encaje") for as long as 2 years or pay an equivalent fee to the central bank; through mid-1998, the rate was 30% for 1 year. Responding to increasing risk premiums charged by creditors and a substantial decline in foreign financial capital flows as a result of the global financial crisis, the Central Bank reduced the rate to 10% in June 1998 and then to zero 2 months later. Investments more than \$50 million may qualify for tax concessions. This encouragement to foreign investment, along with the country's wealth of natural resources, had led to about \$26 billion of foreign investment, including portfolio investments, in the 5 years ending in 1997 (\$8 billion in 1997 alone). Foreign direct investment totaled more than \$25 billion since 1974 and reached \$5 billion in 1997. Foreign investors have purchased many of the assets privatized by the Chilean Government during the past decade. Although access to local financing by foreign investors was not restricted, DL 600 provides that any such restriction of access to local financing imposed on foreign investment would not be viewed as discriminatory (U.S. Embassy, Santiago, Chile, 1999).

Environmental Issues

Comisión Nacional del Medio Ambiente (CONAMA) defines

¹Where necessary, values have been converted from Chilean pesos (Ch\$) to U.S. dollars at the rate of Ch\$460.0=US\$1.00, the average exchange rate in 1998.

Chile's environmental policy, proposes environmental legislation, and develops and maintains the resources necessary for the administration and enforcement of environmental regulations. Comisión Regional del Medio Ambiente (COREMA), the regional subsidiaries, authorize pollution prevention and abatement plans, advise the Ministry of Mining on designing environmental policies and the regulations implementing these policies, diagnosed 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 regulations 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 DL 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 eventually reduce air pollution around Santiago.

DL 185 divided Chile into two zones—the mining district (zone 1, which covers more than one-half of the country, from Rancagua, site of 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.

In 1997, COREMA of Chile's second region gave environmental approval of the copper oxide leach project proposed by Minera Escondida Ltda. The project entailed the blending, crushing, agglomerating, stacking, and leaching of oxide ore, which is not suitable for processing in the existing plant. The oxide ore would otherwise be stockpiled. The copper-rich solutions from the leaching operation will be treated by conventional solvent extraction-electrowining (SX-EW) to yield London Metal Exchange Grade A copper cathode.

Empresa Nacional de Minería (ENAMI) installed a sulfur recovery plant to control sulfur dioxide emissions at its Hernan Videla Lira (Paipote) smelter. 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.

During 1994-99, CODELCO implemented a \$764 million environmental investment program, of which \$215 million was spent in 1998. At the Chuquicamata Division, improvements in the recovery of more than 80% of the sulfur and more than 90% of the arsenic were accomplished. The company expected that with an additional investment of \$78 million, it could improve the recovery of these gases from the Pierce Smith converters to 95% and 97%, respectively. At the Salvador Division's Potrerillos smelter, the MALIGAS project to control and clean the emission of gases was completed at a cost of about \$56 million. These gases will be processed in the new sulfuric acid plant, which was inaugurated this year and will be

fully operative in 1999. The project investment totaled \$97 million, of which \$67 million was expended during 1998. At El Teniente Division, a sulfuric acid plant was completed in August 1998 at a total cost of \$71 million. A second, larger sulfuric acid plant to treat process gases was scheduled to start up in 2000 at CODELCO (Corporación Nacional del Cobre de Chile, 1998a, 95 p.).

Production

The Comisión Chilena del Cobre (COCHILCO) reported that Chilean copper production in 1998 was 3.69 million metric tons per year (Mt/yr), an increase of 8.7% compared with 3.39 Mt/yr in 1997; 1.5 Mt/yr was contributed by CODELCO, or about 40.6% of the total, and the remainder (59.4%) by the private sector. Servicio Nacional de Geología y Minería (SERNAGEOMIN), an agency of the Ministry of Mines, reported that gold production for Chile in 1998 decreased by 9% to 44,980 kilograms (kg), and silver production increased by about 23% to 1,340,200 kg. The medium- and small-sized mines produced 97% of the gold and 78% of the silver in the country, respectively, followed by the large-sized mines of CODELCO, with 3% of the gold and 22% of the silver produced primarily as byproducts of copper operations. Of the total gold production in Chile, 28% was derived from the copper mines.

CODELCO also accounted for all the output of molybdenum in the forms of concentrate, molybdenum oxide, ferromolybdenum, and molybdenum trioxide, and was a major sulfuric acid producer. Its molybdenum production reached 25,298 metric tons (t) in 1998, making Chile the world's third most important producer after the United States and China.

The increase in production of copper by the private sector in 1998 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 1997. (*See table 1.*)

Trade

Chile remained highly dependent on international trade. Chile's economy has grown for more than a decade, but the previous rapid rate of economic expansion was slowing as the country absorbed the double impact of lower commodity prices and shrinking Asian markets. However, foreign investment, which was oriented towards relatively long-term periods, was still substantial. Copper remained the country's most important export product, accounting for about 36% of export earnings in the first 9 months of 1998. In 1998, total exports reached \$15.8 billion and imports \$19.0 billion. Nontraditional exports have grown faster than those of copper and other minerals. In 1998, nontraditional exports accounted for 52% of export earnings. Chile's export markets were geographically diverse. Asia and the EU 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 Mexico, Venezuela, Colombia, and Ecuador. An association agreement with Mercado Común del Cono 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 NAFTA in anticipation of an eventual trade pact with the United States (U.S. Department of State, October 1998, Chile, List server, accessed October 28, 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. CODELCO shipped 1.5 million metric tons (Mt) of fine copper in 1998, 8.3% more than was shipped in 1997.

Revenues from copper sales by CODELCO were about \$2.1 billion, or \$537 million lower than those of 1997, and the revenues from the sale of byproducts amounted to \$289 million, or \$40 million lower than those of 1997, which included \$138 million from sales molybdenum, doré metal, sulfuric acid, and others (Corporación Nacional del Cobre de Chile, 1998b, 95 p.)

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; Empresa Nacional del Petróleo S.A.; Empresa Nacional del Carbón S.A.; 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.

CODELCO comprised five divisions—Andina Division, Chuquicamata Division, Rodomiro Tomic Division, El Teniente Division, and El Salvador Division.

Sociedad Contractual Minera El Abra was formed in 1994 by CODELCO (49%) and Cyprus El Abra Corporation (51%), with Cyprus Amax Minerals Co. as its guarantor, for the development and exploitation of El Abra deposit. Exploitation operations began at the end of 1996. The five CODELCO divisions accounted for about 38.5% of all Chilean copper production in 1998, including the 49% output of copper from El Abra. Rodomiro Tomic startup operation generated 161,896 tons of fine copper. CODELCO was also a producer of gold, metal doré, molybdenum (trioxide, concentrate), and silver, as well as ammonium perrhenate (rhenium) and sulfuric acid.

ENAMI purchased concentrates of copper, gold, and silver; precipitates and minerals for direct smelting; and copper anodes and blister copper 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 1998, the total labor force in Chile was about 5.4 million—42%, industry and commerce; 40%, agriculture, forestry, and fishing; 17%, construction; and 1%, mining. The mineral industry employed 56,799 (including staff and office personnel working directly for the minerals sector). The metal sector employed about 47,409 workers, the industrial minerals sector employed 4,809 miners, and the mineral fuel sector employed 4,581 (including almost 3,000 coal miners). Copper mining employed about 38,500 workers (including its own copper workers and contractors' personnel), or about 68% of the mineral industry. The large-scale copper mining industry employed 18,329 miners and the medium-scale mining industry employed 15,980 (Comisión Chilena del Cobre, 1998).

Commodity Review

Metals

Copper.—Chile's increased copper production in 1998 and 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 3.69 Mt of copper, an 8.8% increase from that of 1997. The increase in production was due to increased output from the small- and medium-sized mining sector, which accounted for 59.4% of the total. An important aspect of the copper mining boom is the emergence of the SX-EW process for the low-cost recovery of refined copper. SX-EW production of copper increased by 25.8% to 1.1 Mt in 1998 compared with that of 1997. 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.

The state-owned firm CODELCO was the world's largest copper-producing company. Financing from foreign private investments helped develop several new mines, and the private sector produced more copper than CODELCO. 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 13% to 1.5 Mt of fine copper with an average grade of 1.07% copper compared with 1.14% in 1997. The increase was due to the start of operations at the Rodomiro Tomic Mine and the 49% contribution of El Abra Mine generating a return of about \$355 million less compared with \$1.0 billion generated in 1997. This indicated a loss of about \$656 million owing to the lower price of copper. The average copper price in 1998 was \$0.75 per pound compared with \$1.03 per pound in 1997. 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 Minerals of the United States, was \$1.8 billion. El Abra project, owned by Cyprus Amax (51%) and CODELCO (49%), was the world's largest copper heap-leach operation with 1998 production of 162,000 metric tons per year (t/yr) at a direct cost of less than \$0.45 per pound.

The Rodomiro Tomic Mine, operated by a new division of CODELCO, is 5 km north of the city of Calama and has 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 an annual production capacity of 160,000 t, and its final product will be copper cathodes of high purity at a direct operating cost of less than \$0.45 per pound (Corporación Nacional del Cobre de Chile, 1998d, 95 p.).

Collahuasi in the north of Chile was one of the largest copper resources known anywhere in the world. It sits at some 4,500 meters (m) above sea level in the Andes, north-northeast of Chuquicamata, 200 km southeast of Iquique. "Measured and indicated geological resources amount to 2,054 Mt, and the inferred resources are estimated to be 1,054 Mt, with an average copper content of 0.82% using a 0.4% cutoff grade." Copper production was forecasted to average 346,000 t/yr in concentrate and 50,000 t/yr in cathodes for the next 5 years. Cathode production came on-stream first, in July 1997. Collahuasi has been described by company officials as probably the largest new mining project to be developed in this decade. At Collahuasi, three major porphyry copper deposits were being developed—Rosario, Ujina, and the geologically complex Huiniquintipa. Rosario was discovered in 1979, and Ujina, 7 km to the east, was discovered in 1991. Ujina was being mined first because of its higher grades and its cost effectiveness. The Rosario deposit is 1 square kilometer in area, and lies within a larger (5-km radius) zone of hydrothermal alteration. Rosario is structurally complex owing to postmineralization faulting. Huiniquintipa is a copper oxide deposit that was formed when copper oxides were deposited as cement in gravels in paleochannels from headwaters in the Rosario sector. La Granja is a system of high-grade massive sulfide copper veins around which secondary enrichment halos of up to 50 m developed. This deposit is still to be fully explored (Mining Magazine, 1999a).

Chile's Collahuasi shipped its first copper-in-concentrates from the port of Punta Patache. The 8,450-t shipment, containing 3,440 t of copper, was bound for Gaspé, Canada. The mine, owned by Falconbridge Ltd., Minorco Plc., and a Japanese consortium, has a nominal capacity of 330,000 t/yr of copper. Planned copper cathode output was 50,000 t/yr. The project shipped its first cathode in August 1998. Minorco took over Chevron's Collahuasi interest in 1992, and in August 1994, Cia. Minera Doña Inés de Collahuasi was incorporated. Minorco and Falconbridge acquired the Shell interest, giving each a 50% share. Completing the ownership story, the joint ventures diluted their holding to 44% each by selling 12% of the project to a Japanese consortium led by Mitsui & Co. Ltd. Collahuasi's primary process plant will be a concentrator of approximately 60,000 metric tons per day (t/d), supported by an

SX-EW plant to recover copper from the oxide ores at a rate of approximately 50,000 t/yr (Mining Magazine, 1999b).

The Phase 3.5 copper oxide expansion at the Escondida Mine in Chile was more than 90% complete, and commissioning was begun. Broken Hill Proprietary Co. Ltd. (BHP) of Australia is the operator of the mine. The first copper cathode was produced from the \$473 million oxide project at Escondida 3 weeks ahead of schedule and within budget. The plant was running at about 50% of capacity, and BHP expected that it would take 6 months to reach the design output of 125,000 t/yr of copper cathode.

BHP (57.5%) and its joint-venture partners, which included Rio Tinto Zinc Corp. Plc., with a 30% stake, Japan Escondida Corp., 10%, and International Finance Corp., 2.5%, were reviewing a number of options for the Phase 4 expansion. Escondida was designed to increase ore throughput to counteract lower grades and thus maintain annual production at around 800,000 t. Escondida saw its total copper production in 1998 fall by 7% to 867,566 t from 932,699 t in 1997, largely as a result of the continuing fall in ore grades. In 1999, ore grades were expected to fall again from 2.75% to 2.12% copper, putting pressure on the company to find ways and means of maintaining overall output levels, as well as keeping costs below the \$0.60/ per pound level. Escondida's cash operating costs currently (1998) stand at around \$0.47 with total costs, including depreciation and loan servicing around \$0.57 (Metal Bulletin, 1998).

Noranda Chile Inversiones Ltda., subsidiary of Noranda Inc. of Canada, announced in April 1998 that it had signed letters of intent to acquire the remainder of the common shares of Fundación Refimet S.A. (Refimet) that it did not already own from Inversiones Mineras del Pacifico S.A. (50.1%), and Compañía Minera Barrick Chile Ltda., a subsidiary of Barrick Gold Corp. (25.1%). Refimet operated a 158,000-t/yr copper smelter in La Negra, 30 km southeast of Antofagasta at 400 m above sea level. The smelter was built in 1993. The smelter is at one of the highest growth areas for copper mine development in the world. Following a successful acquisition of 100% of the common shares of Refimet, Noranda will complete a feasibility study for a 100,000-t/yr expansion. The strategic location, in the northern part of Chile, will enable it to take advantage of further growth opportunities created by new sources of copper concentrate and a strong demand for sulfuric acid. In 1998, Chile exported about 1 Mt/yr of copper concentrate and has the capacity to treat about 1.5 Mt/yr. As much as twice this amount could be produced by 2005 (Mining Journal, 1998a).

Refimet also operated a roaster plant in La Negra for concentrates with high arsenic content, which is fed mainly with El Indio concentrate and materials from their own smelter. Each of the two roasters was capable of processing between 3,000 and 4,000 metric tons per month of concentrates. The roasters were connected to a gas-cleaning system that permits the recovery of arsenic in the trisulfide form.

Empresa Minera de Mantos Blancos S.A. (Mantos Blancos), a subsidiary of Minorco, will invest \$54 million in a project, which will enable it to maintain its copper cathode production at 50,000 t/yr until 2013. The investment will essentially be in a low-grade ore heap-leach project, which should help offset

the decline in output owing to falling ore grades that was expected to begin in 2000. COREMA, the regional environmental body, was evaluating the company's environmental impact statement that had been submitted previously. The new project would involve the treatment of the low-grade material in three phases. The first, from 2000 to 2001, would process 6.5 Mt of ore; the second, from 2002 to 2007, would treat 74 Mt of material; and the third, from 2008 to 2013, would treat 200 Mt (Metals & Minerals, 1998b).

The new Manto Verde SX-EW project, 85 km southeast of the port of Chañaral, was using seawater to leach 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 Santa Bárbara and the Manto Verde SX-EW copper operations in Chile, owned by Mantos Blancos, were operating following plans set by the company late in 1995. Santa Bárbara was an expansion of an open cast mine operated by Mantos Blancos north of Antofagasta. The investment included the installation of a new primary crusher, a conveyor system, and a 30,000-t/yr cathode SX-EW circuit. The company has also extended the mine's life to 2010. Production should continue until the middle of the next decade at current (1998) levels of around 77,400 t/yr, of which 46,000 t/yr will be in the form of copper in concentrates. 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 was being dismantled. At Manto Verde, the new SX-EW plant produced some 570 t of cathode; output in the first year of operation was projected to be 30,000 t. Manto Verde is an opencast heap-leach operation near El Chañaral in the Atacama region. The project has cost about \$180 million and was 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.

A \$351 million expansion to double production was completed at the end of 1997 at La Candelaria copper mine in northern Chile by United States-based Phelps Dodge Corp., which owned an 80% interest in the operation; Sumitomo Metal Mining Co. Ltd., and Sumitomo Corp. held the remaining 20%. Not only was the expansion completed 8 months ahead of schedule (allowing commercial production to start by the end of 1997) and 13% below the budgeted cost, but it also set a new Chilean construction industry record for safety. At the end of 1997, Phelps Dodge reported a minable reserve of 432 Mt averaging 0.88% copper. The expansion cost totaled \$202 million and will bring Candelaria's average annual copper production to about 172,400 t/yr, increasing Phelps Dodge's share of copper production at Candelaria by 59,000 t/yr (Mining Magazine, 1998).

The Quebrada Blanca bioleach copper operation owned by Cominco Ltd. (47.25%), Teck Corp. Ltd. (29.25%), Soc. Minera Pudahuel Ltda., (13.5%), and ENAMI (10%) was planning to produce 70,000 t of electrowon cathode this year, still below its 75,000-t/yr capacity but above that of 66,000 t in 1997. The operation, which started up in late 1994, has suffered from a number of startup problems, as with many bioleach operations. Adding more heat to the process and adjustments to the leach solution recovery system boosted

production. Output was also affected marginally by a strike earlier this year. The partners in the operation expect to reach design capacity for the first time next year, according to a Cominco official. The company was also planning to invest in a low-grade sulfide dump-leaching project to boost production after 2000 (Metals & Minerals, 1998c).

Compañía Minera Cerro Colorado, S.A., the Chilean subsidiary of Rio Algom Inc. of Canada, planned to produce 100,000 t/yr of fine copper by 2000 at its SX-EW operation near Iquique, Chile; this would be 66% more than the plant's original design capacity. The \$200 million expansion (decided on midyear) was proceeding as planned and should help the company bring costs down to \$0.50 per pound at its open pit and heap-leach operation. According to Rio Algom officials, production in 1998 ranged from 70,000 to 75,000 t. Production will rise to 90,000 t next year (Metals & Minerals, 1998a). Cia. Minera Zaldivar in Chile, owned by Minera Outokumpu Chile S.A. and Placer Dome Ltd., was scheduled to produce 128,000 t of fine copper in 1998, slightly above the SX-EW plant's nominal capacity and above the company's original forecast for the year. The increase is the result of improved ore quality, the start-up of the bacterial heap-leaching plant, and increased recoveries from the leach solution. The direct unit cost of production continues to fall and was 26% below the same month last year. In the first 9 months of the year, Zaldivar produced 98,200 t of copper, 46% higher than in the same period of 1997 (Metals & Minerals, 1998d).

The 250,000-t/yr Los Pelambres copper project in Chile was under construction in 1998. The mine, due to start production of copper concentrates in November 1999, is located 3,200 m above sea level in the Andes. The mine was 60% equity owned by the United Kingdom's Antofagasta Holdings, which was controlled by Chile's Luksic family, and 40% by a consortium of Japanese companies. An investment of \$1.3 billion was planned. Los Pelambres will make its first shipment in January 1999 with full production by March 2000. Annual output will be 250,000 t of copper, 995 t of gold, 39,812 t of silver, and 4,500 t of molybdenum concentrates. Los Pelambres has total proven reserves of 3 billion metric tons averaging 0.65% copper, with throughput over the 30-year mine life expected to be 930 Mt, containing 0.63% copper. Production costs are thought to be in the \$0.42- to \$0.43-per-pound range, including credits for gold, molybdenum, and silver (Metals & Minerals, 1999).

Gold and Silver.—Production of gold and silver in 1998 was 45 t and 1,340 t, respectively; this represented a decrease of 9% in gold and an increase of 23% in silver from that of 1997. Most of Chilean gold production was by medium-sized gold mines (73.2%); the large-sized mines of CODELCO produced 26.8% of the gold.

Most of the mines in the area of the Maricunga Gold Belt in Chile's northern Regions II, III, and IV are open pit, except El Indio/Tambo, and many are also heap-leach operations. Rising costs prompted Barrick to announce in September 1997 that it would close El Indio by the end of 1998 and Tambo by the end of 1999. El Indio/Tambo combined to produce Chile's largest gold output up until 1997. Barrick intended to employ the

workforce at its 11-million-metric-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, however, were delaying completion of the study. Further exploration of the property began in March 1998, and a feasibility study was underway (Mining Journal, 1998a).

The second largest gold producer in the private sector in Chile was La Coipa Mine, owned by Placer Dome and TVX Gold Inc. of Canada. In 1998, it became the largest gold producer in the country, with a reported production of 6.5 t of gold and 319.7 t of silver, which made it one of the largest silver mines in the world. Chile's copper mines also were significant producers of gold. For example, Escondida, the largest copper mine in the world, was actually the third largest gold producer in Chile in 1998, with an output of 5.5 t. La Candelaria recovered more than 3.0 t of gold, and Andacollo produced almost 2.9 t in 1998. El Refugio produced 7.2 t of gold in 1998, followed by CODELCO with 1.29 t. Other important producers of byproduct silver were El Indio, La Escondida, El Bronce de Petorca, Sociedad Contractual Minera Vilacollo, (SCM Vilacollo) Choquelimpie Mine, El Hueso (Homestake), San Cristóbal (Niugini) and the 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 capital investment.

El Refugio (Bema, Cyprus Amax), in northern Chile, produced a total of 1.5 t of gold during the first quarter of 1998, a 25% increase in production over the last quarter of 1997. In September 1997, a loan 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.

San Cristobal (Niugini Mining Lt., Pacific Rim Gold) in Region II, is a low-sulfur disseminated gold system, which produced 1,500 kg of gold in 1998. The open pit is currently schedule for closure in 1999. New production is expected in 1999 from Palely (Pegasus Gold), El Peón (Meridian) and Aldebarán/Cerro Casale (Placer Dome, Bema Gold, Arizona Star Resources Corp.). In February 1998, Placer Dome agreed to pay \$10 million cash and \$10 million in Bema Gold and Arizona Star stock, together with \$40 million in exploration and work on the Cerro Casale property. A new company capitalized at \$200 million was formed; Placer Dome owned 51%, and Bema Gold and Arizona Star together owned 49%. Placer Dome was expected to put up 85% of the expected \$1.3 billion cost of construction and to complete the feasibility study by February 2000. Cerro Casale hosts a resources of some 606.5 t of gold with planned production of 28 t/yr during 21 years. Within the Maricunga gold belt in Region III, the Marte Lobo project (Teck, Mantos Blancos) had an anticipated production capacity of 9.3 t/yr of gold for an investment of \$250 million. Water, refining, and waste problems were

revealed within the planned location during preliminary investigations. Plans for construction were halted with the company citing low gold prices (Mining Journal, 1998b).

Iron Ore, Manganese, and Steel.—In 1998, Chilean iron ore production increased by 4.3% to 9.1 Mt. The III Atacama Region contributed with 55.3% and the IV Coquimbo Region with 44.7% of the total. From the total production, more than 8% was consumed by the Huachipato steel plant. Last year, Cia Minera del Pacifico, S.A. (CMP) began developing the Colorado East pit at its Los Colorados iron ore deposit. The Colorado East pit was expected to produce about 5.4 Mt/yr. Design work also began for the new pit's beneficiation plant, which was expected to begin operations in 1998. The nearby Los Colorados pit has been in production for some time but has produced only 1.17 Mt/yr of pellet feed. The new pit was intended to be a replacement for the Algarrobo pit, which was expected to close in 1998. The project, named Cia. Minera Huasco (CMH), was a 50-50 joint venture between CMP and Mitsubishi Corp. The 4-Mt/yr Huasco pellet plant, which remained CMP's property, will be leased to CMH. The plant was expected to produce 3.2 Mt/yr of blast furnace pellets and 0.8 Mt/yr of pellets for direct reduction. Exports of Chilean iron ore in 1998 totaled 6.5 Mt, down 5% from that of 1997. Out of the total, exports to Japan stood at 3.2 Mt, slightly more than the level of 1997, and accounted for 48.7% share of the total exports.

Manganesos Atacama, S.A. (MASA), a Swiss-Chilean industrial group and subsidiary of Compañía Aceros del Pacífico (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 El Corral Quemado and Los Loros Mine in Region IV. During 1998, production of manganese decreased by 23% to 48,931 t compared with that of 1997. Most of the manganese produced by MASA was bought by the Huachipato smelter.

The production of steel ingots at Huachipato amounted to 1.17 Mt, or 0.3% higher than that of 1997. CAP reported that to increase the production capacity at its Huachipato smelter and to reduce operating costs, it was considering an investment to modernize the plant.

Zinc.—The largest zinc mine in Chile was the El Toqui Mine, operated by Sociedad Contractual Minera, Ltda. El Toqui (SCMT), which was owned by Breakwater Resources Ltd. of Canada and is near Coihaique in southern Chile. Despite problems resulting from low prices, SCMT began mining operations again at El Toqui zinc mine. The mine had suspended ore mining until a stockpile of ore was depleted. The company achieved a decrease in production in the calendar year, with output figures of 15,943 t of zinc, or 53% less than that of 1997, and 337 t of lead, down 73% from the previous year. The decreased in output was attributed by Breakwater to the restart of the Bougrine zinc-lead mine in Tunisia, which had been shut down in 1996 in response to low metal prices.

Industrial Minerals

Lithium and Potassium.—Chile was the second largest lithium chemical producer in the world followed by China. The United States closed down one of its largest mines and lithium carbonate plants in North Carolina. Production of Chilean lithium carbonate in 1998 was 28,313 t, or 17% more than that of 1997. Sociedad Química y Minera de Chile S.A. (S.M.), the world's largest producer and distributor of iodine and its derivatives, increased its output of existing chemical products. One of the first stages of its investment program will be to fund the development of a new lithium chloride facility in Antofagasta. Having recently secured the necessary construction permits, S.M. will develop a plant to treat lithium carbonate to produce a number of derivative products. The output of lithium carbonate has already been doubled in 1998 to more than 28,000 t/yr.

Part of the S.M. investment has already gone towards expanding the company's Salar de Atacama potash plant in northern Chile's Atacama Desert. Expansion has increased capacity from 300,000 t/yr of potassium chloride to 500,000 t/yr as of March 1998. Of this volume, 350,000 t/yr will be used in the company's own facilities to produce potassium nitrate. The remainder will be sold to Europe, 40,000 t/yr; China, 30,000 t/yr; and South America, 80,000 t/yr (50,000 t/yr of this was sold in Brazil). New projects to produce boric acid and potassium sulfate will be on-stream shortly. Minsal, the corporate arm responsible for its lithium and potassium products, has ceased to exist. Instead, the newly formed S.M. Chemicals will control the lithium operation and its iodine output. Potash, potassium sulfate, and boric acid will now be produced by Soc. Minera Salar de Atacama Ltda. (S.M. Salar). The corporate structure of S.M. Nitrates (sodium and potassium nitrates and sodium sulfate) and Cementos Chile remained unchanged. S.M. Nitrates was the major nitrate producer in Chile, and produced 882,000 t of nitrate in 1998, a 4.1% increase from that of the previous year. An integrated producer and distributor of specialty fertilizers, industrial chemicals, iodine and lithium, S.M. Nitrates processed the raw materials consisting of caliche and Salar de Atacama, brines in Regions I and II. The Salar de Atacama brines contain high concentrations of lithium, potassium sulfate, boron, and magnesium, allowing S.M. to be one of the lowest cost potassium chloride and lithium carbonate producers worldwide. In 1998, S.M. planned to add potassium sulfate and boric acid production. The main objective will be to provide raw materials for the rapidly increasing production of potassium nitrate.

Nitrates and Iodine.—Cía Minera Yolanda S.A., a Chilean subsidiary of KAP Resources Ltd. of Canada, in the Taltal zone of Region II, was planning to produce about 357,000 t/yr of potassium nitrate, 300,000 t/yr of sodium 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 recrystallization. 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.

S.M. Yodo also planned 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. The company also reported that as a result of the expansion, it expected to produce about 8,000 t of iodine in 1998 with the extraction of caliche ore at the Pampa Blanca, the Coya Norte, and the Pampa Toco deposits.

Sulfur.—Chile has been an importer and producer of sulfur for many years. In 1998, most sulfur was imported from 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 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, each with a capacity to process 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 start-up date was reported.

Consumption of sulfuric acid in Chile amounted to 900,000 t/yr. Start-up of new sulfuric acid plants that use gases from the smelters will increase Chile's production by more than 2.0 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 Smelter).

Mineral Fuels

Coal.—In the energy sector, bituminous coal production decreased to 921,000 t in 1998 from 1 Mt in 1997. The Chilean Government encouraged greater domestic coal production as a means of reducing the dependence on petroleum. Chile, with a population of more than 13.7 million, had 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 and is also developing the Isla Riesco coal project also owned by COCAR. In 1998, production from the Pecket Mine was about 82% of the total. COCAR has a long-term contract with CODELCO 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.

Empresa Nacional del Carbón, S.A. (ENACAR) was the second largest coal producer in Chile, operating three mines

and a plant in the Lota/Curanilahue area of Region VIII. Bituminous coal was found in underground deposits in Region VIII. Operations were carried out in this area by ENACAR producing around 200,000 t/yr, and Carbonífera Schwagner, S.A. contributing 140,000 t/yr.

ENACAR received 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 3.1 billion cubic meters in 1998, continuing the declining trend that began in 1990. State firm ENAP's exploration director indicated the company was concentrating on finding subtle traps of oil between the fields of Magallanes.

Cardinal Resources Inc. from White Plains, New York, completed surface gravity-magnetic surveys last year in the Tamarugal basin of northern Chile. Results were encouraging, but the company had the option to withdraw each March from its \$500,000-per-year exploration commitment. An exploration well must be drilled by March 2001.

The 51-centimeter (cm) Gas Atacama pipeline project is currently under construction, beating two possible competing projects. Numerous supply contracts were signed in recent months that should ensure success when the line opens in spring 1999. The pipeline is owned by CMS Energy Corp. (40%), Empresa Nacional de Electricidad S.A. (ENDESA) (40%) and Pluspetrol Inc. (20%) (World Oil, 1998).

The Gas Atacama pipeline extended from Cornejo in the Northeast basin in Argentina, across the Andes to the port of Mejillones in Chile. As an extension to the Atacama pipeline, ENDESA was planning to build a pipeline south from Mejillones to the town of Taltal. Gas supply contracts have been agreed with Astra S.A., Pluspetrol Energy Corp., and Argentina's YPF S.A. Under the terms of the contract, Astra S.A. and Pluspetrol Energy Corp. will supply 2.65 million cubic meters per day (Mm³/d) for a 15-year period, commencing in January 1999. This gas will most likely be supplied from the Ramos Gasfield in the Northeast Basin in which Pluspetrol and Astra have ownership along with Tecpetrol. The total cost of the integrated project was estimated to be approximately \$900 million. In addition to the pipeline, which will cost around \$400 million, construction started in October 1997 on a 710-megawatt (MW) gasfired powerplant at Mejillones in Chile. The first unit of the powerplant is due to come on line in February 1999 followed by a second unit in April 2000. Investment in this portion of the project was estimated to be \$450 million.

The pipeline will have an initial capacity of 3 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 integrated power project and pipeline should be operational by 1999. The Gas del Sur pipeline would run from the Neuquén gasfields in southern Argentina to Chile's industrial city, Concepción.

Petroleum.—Chile must import increasing quantities of oil and gas to satisfy its robust growth. In the past 10 years, oil demand has doubled, and production has decline by two-thirds. As a result, the nation must import most of its oil, with 60% now coming from Argentina. Chilean production of crude oil decreased by 4.2% in 1998 to 2.9 million barrels.

Infrastructure

Chile had a 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 has been made in the railways. The 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. The Chilean Government announced in December 1995 that it would privatize the railroad system, including infrastructure, maintenance, and operations. According to the Government's plan, by 2000, a new operational passenger railroad system from Santiago, the capital, to Puerto Montt, in the south, will be in place. Until now, the privatization process of the passenger railroad system has not been initiated. On May 21, 1997, however, 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. 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, Chañaral, 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. In addition, a 450-km, 41-cm 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

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. The Canada-Chile Free Trade Agreement includes no safeguards against predatory pricing and also paves the way for possible expansion of the much larger NAFTA covering Canada, Mexico, and the United States. This is a solid

stepping stone for getting Chile into NAFTA, and on October 1, 1998, Chile became an associated member of MERCOSUR. Chile still maintains its common external tariff of 11%, and MERCOSUR has 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 the year 1999, an increase of more than 29%, representing more than 39% of world supply. (International Copper Study Group, May 2000). Gold was projected to decrease from about 49,459 kg in 1997 to 48,069 kg by 1999, representing a decrease of more than 2.8%; and silver was projected to increase from 1,091,311 kg in 1997 to about 1,381,000 kg by 1999, representing an increase of more than 26.5% (Servicio Nacional de Geología y Minería, Chile, 1999).

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. The production of bentonite, boric acid, diatomite, nitrates, potassium chloride, potassium sulfate, and sulfuric acid were also expected to increase by significant amounts in 1999.

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.

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Major Sources of Information

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Major Publications

Comisión Chilena del Cobre: Estadísticas del Cobre y otros Minerales.

Corporación Nacional del Cobre de Chile: Annual report.

Servicio Nacional de Geología y Minería, Chile: Anuario de la Minería de Chile.

TABLE 1
CHILE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 e/
METALS					
Arsenic trioxide e/	4,050	4,076 3/	8,000	8,350 3/	8,400
Copper:					
Mine output, Cu content 4/	2,220	2,489	3,116	3,392	3,691 3/
Metal:					
Smelter, primary 5/	1,235	1,294	1,356	1,390 r/	1,403 3/
Refined: 6/					
Fire-refined, primary	201	373	636	881	1,108 3/
Electrolytic	1,076	1,119	1,113	1,236	1,227 3/
Total	1,277	1,492	1,749	2,117	2,335 3/
Gold, mine output, Au content	38,786	44,585	53,174	49,459	44,980
Iron and steel:					
Iron ore and concentrate:					
Gross weight	8,341	8,432	9,082	8,738	9,112 3/
Fe content	5,167	5,233	5,275	5,437 r/	5,540
Metal:					
Pig iron	886	855	996 r/	941 r/	992 3/
Ferroalloys:					
Ferrochromium	1,579	2,730	2,079 r/	2,000 r/	2,000
Ferromanganese	9,646 r/	7,987	8,498 r/	5,517 r/	6,000
Ferromolybdenum	3,082 r/	3,241 r/	4,222 r/	3,157 r/	3,300
Ferrosilicomanganese	995	1,617	1,599 r/	3,175 r/	3,000
Ferrosilicon	5,504 r/	4,279 r/	4,650 r/	1,294 r/	1,500
Total	20,806 r/	19,854 r/	21,048 r/	15,143 r/	15,800
Steel, crude 7/	1,041	1,018	1,135	1,167 r/	1,171 3/
Semimanufactures	889 r/	886 r/	1,095 r/	1,062 r/	924 3/
Lead, mine output, Pb content	1,008	944	1,374	1,264	337 3/
Manganese ore and concentrate:					
Gross weight	62,870	70,449	62,887	63,673	48,931 3/
Mn content	18,175	20,188	18,630	18,860	14,680 3/
Molybdenum:					
Mine output, Mo content	16,028 r/	17,889	17,415	21,339	25,298 3/
Oxides	7,980	9,672	17,523	19,291	19,300
Rhenium, mine output, Re content	1,479	2,628	2,600 e/	2,500 e/	2,500
Selenium e/	43,000 3/	51,000	50,000	49,500	49,000
Silver	983	1,041	1,147	1,091	1,340
Zinc, mine output, Zn content	31,038	35,403	36,004	33,934	15,943 3/
INDUSTRIAL MINERALS					
Barite	3,670	3,080	2,559	2,654	2,660
Bentonite	1,213	684	1,191	717	721
Borates, crude, natural (ulexite)	85,935	211,312	149,008	170,605	280,140 3/
Cement, hydraulic	2,995	3,275	3,634	3,735	3,750
Calcite (chalk) e/	6,300 3/	6,300	6,300	6,200	6,250
Clays					
Kaolin	73,081	10,845	13,452	14,238	11,530 3/
Other (unspecified)	37,553	28,725	18,462	14,537	14,500
Diatomite	10,129	11,451	11,592	11,825	14,868 3/
Dolomite	4,729	4,631	2,569	11,840	16,473 3/
Feldspar	9,967	7,293	3,702	3,808	1,460 3/
Gypsum:					
Crude	552	464	520	398	781 3/
Calcined	201	203	200 e/	200 e/	200
Iodine, elemental	4,884 r/	5,103 r/	5,514	7,154	12,618 3/
Lapis lazuli	218	190	150	118 e/	58 3/
Lime, hydraulic	1,300	1,006	1,050	1,000 e/	1,000
Lithium carbonate	10,439	12,943	14,180	24,246	28,313 3/
Nitrogen, natural crude nitrates: e/					
Sodium (NaNO ₃)	673	732	662 3/	693	722 3/
Potassium (KNO ₃)	149	163	147 3/	154	160 3/
Total	822	895	809 3/	847	882 3/

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 e/
INDUSTRIAL MINERALS--Continued					
Phosphate rock (apatite)	9,975	12,164	17,356	12,605	15,065 3/
Pigments, mineral, natural, Iron oxide	3,283	16,451	18,821	10,678 r/	10,449 3/
Potash, K equivalent e/	50,000 3/	52,100	180,000	150,000	100,000
Potassium chloride (KCL)	83,026	84,290	80,000 e/	80,000 e/	80,000
Pumice (includes pozzolan) thousand tons	452	466	500	491	912 3/
Quartz, common do.	543	598	583	555	641 3/
Salt, all types do.	3,178	3,494	4,043	5,488	6,207 3/
Sodium compounds, n.e.s., Sulfate 8/	43,168	50,718	44,345	64,335	51,928 3/
Sand and gravel (silica) e/ thousand tons	300	300	300	300	300
Stone:					
Limestone (calcium carbonate) do.	6,035	5,912	6,009	5,618	5,993 3/
Marble	2,376	5,908	401	1,248	1,427 3/
Sulfur, byproduct, from smelters and oil refining	524,000 r/	588,000 r/	587,000 r/	768,000 r/	899,000 3/
Talc	5,351	4,107	4,276	3,986	3,772 3/
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous and lignite thousand tons	1,663 r/	1,485 r/	1,444 r/	1,413	921 3/
Coke, coke oven e/ do.	350	350	350	350	350
Gas natural:					
Gross million cubic meters	4,244 r/	3,783 r/	3,632 r/	3,211	3,075 3/
Marketed do.	2,050	1,860	1,911	1,900 e/	1,900
Natural gas liquids:					
Natural gasoline thousand 42-gallon barrels	1,124	970	1,000 e/	1,100 e/	1,100
Liquefied petroleum gas do.	3,256	2,810	2,800 e/	2,900 e/	2,880
Total do.	4,380	3,780	3,800 e/	4,000 e/	3,980
Petroleum:					
Crude do.	4,491	3,806	3,351	3,076	2,948 3/
Refinery products:					
Liquefied petroleum gas do.	5,078	5,351	3,585	3,918	3,350
Gasoline:					
Aviation do.	50 e/	50 e/	83	74	75
Motor do.	15,901	14,875	15,744	16,491	16,500
Jet fuel do.	2,811	2,900	2,744	3,764	3,800
Kerosene do.	2,081	2,240	2,443	2,108	2,100
Distillate fuel oil do.	19,612	21,203	20,132	20,989	21,000
Residual fuel oil do.	8,870	14,753	9,812	10,590	10,600
Unspecified do.	3,184	1,524	4,715	4,641	4,650
Total do.	57,587	62,896	59,258	62,575	62,075

e/ Estimated. r/ Revised.

1/ Table includes data available through February 1999.

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: 1994--2,233 (Revised); 1995--2,510; 1996--3,144; 1997--3,438; 1998--3,764.

5/ Detailed statistics on electrowinning are now available and reported by the International Copper Study Group Copper Bulletin (January 1996) as follows, in metric tons: 1994--201.0 (Revised); 1995--372.5; 1996--635.7; 1997--881.0 (Revised); 1998--1,108.

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

TABLE 2
CHILE: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Coal (bituminous)	Empresa Nacional del Carbón, S.A. (ENACAR), subsidiary of Corporación de Fomento de la Producción (CORFO) Government, 40%; private, 60%	Three mines: Colico, La Chulita, Trongol and a Planta Lota in Lota/Curanilahue in Region VIII.	66.
Do.	Carbonífera Schwagner, S.A. (Agencias Universales S.A. 61% private shareholders, 39%)	Regions X and XII (Closed since 1994)	170.
Do. (subbituminous coal)	Cía. de Carbones de Chile, S.A. (COCAR) [Cía. de Petroleos, de Chile, S.A., (45.05%); International Finance Corp. (IFC) (9.9%) and Inversiones Ultraterra S.A. (45.05%).	Pecket Coal mine Region XII, open pit mine	1,300.
Copper	Corporación Nacional del Cobre de Chile, S.A. (CODELCO) (100% Government)	Mines:	
		Chuquicamata	650.
		El Teniente	343.
		Andina	146.
		El Salvador	88.
		Rodomiro Tomic	4.
	Cyprus Amax Minerals Co. (51%); CODELCO (49%)	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.	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, silver	Empresa Nacional de Minería de Chile (ENAMI) (100% Government)	Plants:	270.
		Taltal, Salado, Matta, Vallenar 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.	Cía. Contractual Minera Candelaria-Phelps Dodge Corp. (80%)	(Cu,Au,Ag)-Mine Región III, Copiapó	137 Cu, 2,500 kg Au.
Do.	Sumitomo Metal Mining Co. Ltd. (15%), Sumitomo Corp. (5%)	Open pit, concentration plant	30,000 kg Ag.
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	300.
Do.	Cía. Contractual Minera Candelaria (Phelps Dodge, 80%) Sumitomo Metal Mining Co. Ltd. (15%), Sumitomo Corp. (5%)	Mine 22 kilometers SE of Copiapo	2,488 kg Au.

See footnote at end of table

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

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Copper, gold, and silver	kilograms	Cía. Minera El Indio (Barrick Chile Ltda. 82.9%)	El Indio Mine, Concentration Plant, Region IV, Tambo and Pascua (Nevada), Region IV.	5,900 Au, 5,400 Au.
Do.	do.	CODELCO (byproduct from copper) (Government, 100%)	Chuquicamata, El Teniente, El Salvador, and Andina	1,300 Au, 248 Ag, 1,227 Cu.
Gold and silver	do.	Cía. Minera El Bronce de Petorca (private, 100%)	Carmencita 240, Las Condes, Santiago	52,700 Au.
Do.	do.	Cía. Minera Mantos de Oro Ltd. (Placer Dome Ltd. 50%, TVX Gold Inc. 50%)	Ladera Farellon, and Farellon Bajo, Region III	8,600 Au, 358,000 Ag.
Iodine	metric tons	Sociedad Química y Minera de Chile, S.A. subsidiary of CORFO (private, 65%; Government, 35%)	Miraflores No. 222, Santiago, Chile Maria Elena, Pedro de Valdivia	7,150 Iodine.
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 Province	8,400.
Iron ore pellets		do.	Minas El Romeral, El Algarrobo, Los Colorados, Region III, and El Romeral, Region IV, La Serena Province	5,200.
Lead and zinc		Soc. Contractural Minera Ltda. El Toqui.	Baquedeno 238, Coyhaique., Region XI	500 Zn.
Do.		Breakwater Resources Ltd., Canada	Doña Rosa (Zn, Au)	470 (kg Au).
Lithium carbonate		Soc. Chilena de Litio Ltda. (subsidiary of Cyprus/ Amax Minerals Co. of the United States) (private, 100%)	Salar de Atacama, Production of lithium carbonate and potash, Region II	20.0.
Do.		Soc. Minera Salar de Atacama (Minsal S.A.)	Toconao s/n Atacama, Chile	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.

TABLE 3
CHILE--MAJOR MINERAL INVESTMENTS, 1994-99 e/

(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	Falconbridge 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 Nacional 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 Co. Ltd., Rio Tinto Zinc Corp. Plc., 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 Yellowknife Resources Inc.	36	1996
II	Fundicion La Negra	Copper	American Barrick, Noranda Inc.	48	1997
II	Refimmet (smelter)	do.	Inversiones Mineras del Pacifico S.A., 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	TBD
II	La Candelaria	Copper/gold/silver	Phelps Dodge Corp. (80%), Sumitomo Metal Mining (15%),	1,500	1994
II	Sierra Gorda	Copper	Yuma Gold Mines Ltd.	85	TBD
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. (Chile), Outokumpu of Finland	100	TBD
III	La Candelaria	Copper/gold/silver	Phelps Dodge Corp. (80%), Sumitomo Metal Mining (15%) Sumitomo Corp. (5%)	1,500	1994
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	TBD
III	Cerro Casale	do.	Placer Dome Ltd.	792	TBD
III	Lobo Marte	do.	do.	300	TBD
III	Los Colorados	Iron ore	Mitsubishi of Japan	100	1998
IV	Los Pelambres (expansion)	Copper	Luksic Group of Chile and Japanese consortium 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	TBD
IV	Andacollo Cobre	Copper	ENAMI (Chile), Tungsten Int. Inc. (Canada), Cia. Minera del Pacifico S.A. (Chile)	55	1997
XI	Fachinal	Gold/silver	Coeur d'Alene Mines Corp.	85	1996

e/ Estimated. TBD To be determined.