

THE MINERAL INDUSTRY OF

CHILE

By Pablo Velasco¹

Radical political and economic reforms carried out in Chile during the 1970's and 1980's consolidated the country as a market economy, which became a model for policy makers of other Latin American nations. In 1994, Chile continued to be the top producer and exporter of copper (in terms of volume and value) and was probably the single most active mining country in the world.

The good performance of the copper subsector affected production in the molybdenum, gold, and iron subsectors, which also increased at the rates 7.6%, 14.8%, and 13%, respectively. However, the mining sector's 2.7% rate of increase in terms of gross domestic product (GDP) continued as the lowest in the country in 1994 due to the negative performance of the coal and petroleum subsectors. Chile was also one of the world's significant producers and exporters of potassium nitrate and sodium nitrate, and ranked second after the United States in world production of iodine, lithium, molybdenum, and rhenium.

Preliminary data indicated that the Chilean economy registered a real GDP growth of 4.4% to \$47 billion² in 1994, the seventh highest annual rate in the past 35 years, while per capita income increased to about \$3,500.

Government Policies and Programs

Two laws regulated foreign investment in Chile: One was Decree Law No. 600 of 1974, which was amended in 1977 and reformed in 1993. This law, also referred to as the "Foreign Investment Statute," established a standard that became the model for many countries in the Latin American area and was the benchmark for foreign investment legislation in Chile. The other was Title I, Chapter XIX (Compendium of Foreign Exchange Rules issued by the Central Bank of Chile). As stipulated by this law, foreign investors, either as individuals or corporations, may use Chilean foreign-debt titles payable abroad, maturing within 365 days, to invest in the country. This law provided the legal framework guaranteeing the rights of foreign investors and established maximum tax rates, offshore accounts, and a minimum period after which profits and capital could be repatriated.

The Government of Chile made the environment a priority. A new Environmental Framework Law (EFL), known as the Basic Law on the environment, was signed by the President of Chile on March 1, 1994, establishing legally the National Commission on the Environment (CONAMA) and 12

Regional Environmental Commissions (COREMA) as coordinating governmental agencies for environmental protection. The commissions would be in charge of developing and coordinating environmental policies and setting up modern tools for the implementation and enforcement of that policy. The most important of these policies were passed in mid-1994. Regulations implementing the Law have been signed by the President and were expected to be published soon.

The Chilean mining industry experienced another year of continued growth in 1994 as a result of new foreign investment, the increase in output from the private sector's La Candelaria and Quebrada Blanca Mines and the new expansion of the giant Escondida Mine, with its new copper cathode plant capable of producing 80,000 metric tons per year (mt/a) of high-grade copper. Escondida production reached 480,000 mt/a in 1994 and, after an additional \$520 million investment, was expected to increase production to 800,000 mt/a by 1996. That would make Escondida, in terms of production, the largest copper mine in the world.

According to the Chilean Copper Commission (COCHILCO), most of the foreign investment in the mining sector was concentrated during the last 6 years in the following 20 projects: Cerro Colorado, \$286 million; Rio Algom of Canada (copper); Quebrada Blanca, \$373 million, Cominco and the Teck Corp. of Canada and Pudahuel and Enami of Chile (copper); Collahuasi, \$1 billion, Minorco and Falconbridge of Canada, and Shell of the United Kingdom; Minorco, Luxembourg (copper); El Abra, \$1 billion, Cyprus AMAX of the United States and Corporacion Nacional del Cobre de Chile (CODELCO-Chile), (copper); Ivan-Zar, \$36 million, RayRock of Canada, (copper); Escondida, \$1.6 billion, Broken Hill Proprietary Co. Ltd. of Australia, Rio Tinto Zinc of United Kingdom, Japan Escondida Corporation of Japan, and International Finance Corporation of the United States; Manto Verde, \$150 million, Marvis and Anglo American of South Africa, (copper); La Candelaria, \$538 million, Phelps Dodge of the United States and Sumitomo of Japan, (copper); Guanaco, \$70 million, AMAX Gold Inc. of the United States, (gold); Refugio, \$130 million, Bema Gold of Canada and AMAX Gold Inc. of the United States, (gold); Andacollo, \$50 million, Dayton Development Corp. of Canada, (gold); Fachinal, \$52 million, Coeur d'Alene Mines Corp. of the United States (gold, silver, lead and zinc); Yolanda, \$45 million, Kap Resources Ltd. of Canada and British Columbia

Ltd. of Canada, (nitrates and iodine); La Coipa, \$400 million, Placer Dome and TVX mining of Canada (gold); Marte, \$47 million, Cominco of Canada; Anglo American Chile Ltd.; Mantos Blancos and Chemical Bank N.Y. of the United States (gold); La Pepa, \$24 million, Bridger Resources Inc. of Canada, and Cluff Mineral Exploration of United Kingdom (gold); Los Pelambres, \$53 million, Minera Anaconda of the United States and Lucky Goldstar of Canada (copper/molybdenum); Los Bronces, \$400 million, Exxon Minerals International Inc. of the United States (copper); Lince, \$60 million, Carolina de Michilla of Chile, Outokumpu Oy of Finland, and Chemical Bank of the United States (copper); and Zaldivar, \$600 million, Placer Dome Inc. of Canada, Outokumpu, and Copper Resources Chile B.V. of Chile (copper). Some of these projects were recently initiated and others were in advanced stages of construction.

Environmental Issues

Chile experienced a host of environmental problems resulting from years of rapid development of its natural resources. In recent years, the severe environmental problems the country faced have brought the need for environmental protection into the spotlight. Chilean environmental protection regulations were fragmentary and uncoordinated before the 1990's. Many environmental laws and regulations went entirely unenforced, while limited resources restricted the enforcement of others. CONAMA was established by the Government in June 1990, soon after democracy was restored in the country, and began operations as an advisory body to the President. At yearend 1993, Congress was still working on an ecologic master plan to cope with the country's regulations on sulfur dioxide, (SO₂) particulate and arsenic emissions. In March 1994, the EFL was approved by the President after being debated for a year in the Congress. It reestablished the CONAMA as the agency in charge of developing and coordinating environmental policies and setting up modern regulations for the implementation of environmental policies. The passage of the EFL transformed CONAMA into an Interministerial coordinating entity under the Minister of the Presidency. CONAMA's board of directors was chaired by the Minister of the Presidency and made up of the Ministers of Economy; Development; Public Works; Agriculture; Public Lands; Health; Mining; Housing and Urban Development; Transportation and Telecommunication; and Planning and Cooperation. The EFL included the following important provisions: institutionalization of CONAMA, establishment of a system of Environmental Impact Assessment/Declarations, establishment of Standards for the Protection of the Environment, creation of a system of Pollution Prevention and Decontamination Plans, establishment of a Legal Cause of Action for Environmental Restoration (Accion de Reparacion), and a civil procedure for the enforcement of environmental regulations. However, CONAMA faced a difficult task—unlike similar agencies in other countries, CONAMA had no enforcement power and

title in the way of implementation, and it was responsible for coordinating a fragmented system of environmental regulations developed during the past 100 years. Ministries' responsibilities overlapped in some areas. It had a budget of some \$11 million in 1994, of which \$4.3 million was part of a 5-year, \$30 million World Bank Loan. World Bank financing was expected to cover more than 50% of CONAMA's budget for the next 3 years, after which the Government would take responsibility. CONAMA had the legal mandate to define Chile's environmental policy, propose environmental legislation, and develop and maintain the resources necessary for environmental administration. CONAMA was represented in the 13 Chilean Regions by the Regional Commissions for the Environment, or COREMAS. Each COREMA was presided over by the Regional Intendant (an appointed official approximately equivalent to a U.S. Governor) and made up of Regional-Government Representatives, and private sector and non-Governmental organization (NGO) representatives. Each COREMA was the agency charged with the implementation and enforcement of new regulations, and through its regional subsidiaries, authorized pollution prevention and abatement plans, advised the Ministry of Mining on designing and implementing environmental policies and regulations on controlling their implementation; on diagnosing environmental impacts; and on developing of general environmental objectives and policy responses.

Regulations to implement most provisions of the Law were signed by the President and were expected to be published soon. The legislation established equal rights and responsibilities for both public and private enterprises. The Government intended to phase in the legislation's 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 and was implementing regulations covering disposal of waste in coastal zones. It also took some initial steps to contain and eventually reduce the more intractable problem of Santiago's severe air pollution.

The legislation divided the country into two zones: the mining district (Zone 1) covering more than one-half of the country, starting with Rancagua, where the El Teniente smelter is located and ending at the border with Peru; and the agricultural-industrial part of the country (Zone 2) south of Rancagua, stretching to Tierra del Fuego. The decree stipulated that Zone 1 must meet emission standards published by the U.S. Environmental Protection Agency, and Zone 2 must meet the considerably tighter air pollution standards in force in Scandinavia. The cost of enforcing this legislation, particularly in Zone 1, fell on the State, since Empresa Nacional de Minería (ENAMI) and CODELCO smelt 90% of Chile's concentrates. To be in compliance, CODELCO would be required to invest \$300 million during the next 5 years to clean up the Chuquicamata stack gases by shutting down all reverberators and replacing them with Teniente-type converters, to add a third sulfuric acid plant,

and to expand oxygen production capacity. Pollution from arsenic emissions was a more serious problem as far as setting legal limits were concerned, because the Mining Ministry did not believe that there was an acceptable standard in place anywhere in the world. Consequently, the University of Chile was given a contract (funded by CODELCO, Cia. Minera El Indio, and Refimet) to define the health hazards posed by arsenic exposure at the levels currently reported in the Chuquicamata/Calama District. New mines, such as Escondida and Exxon in its expansion of the Chagres smelter, and Disputada Mine have voluntarily funded ecological impact studies, and designed their operations accordingly. ENAMI presented a plan to reduce emissions at its Paipote smelter at Copiapo. By the year 2000, the plan called for a reduction in SO₂. The \$90 million plan included decommissioning of the reverberator furnace, increasing the capacity of the Modified El Teniente Converter, a new oxygen plant, and a new sulfuric acid plant.

Production

COCHILCO reported that Chilean copper production increased 8.0% to 2.22 million metric tons per year (Mmt/a) compared with that of 1993, of which 1.13 Mmt/a was contributed by CODELCO and the remainder by the private sector. The National Service of Mining and Geology (SERNAGEOMIN), an agency under the Ministry of Mines, reported that gold production in 1994 increased 14.8% to 38,800 kilograms (kg) (another record high for Chile) and silver production decreased 1.3% to 983 kg in 1994. The medium- and small-size mines produced 93.4% of the gold and 76.7% of the silver in the country, followed by the large-size mines of CODELCO, with 6.6% of the gold and 24.3% of the silver produced primarily as byproducts of their copper operation.

CODELCO accounted for all of the output of molybdenum in the form of molybdenum trioxide and concentrate. In addition, CODELCO was a major sulfuric acid producer.

The increase in production of copper by the private sector in 1994 established new benchmark in Chile's copper output because of the startup of three large new projects, La Candelaria, La Escondida, and Quebrada Blanca. These new mines had increased copper output about 65,500 metric tons (mt), or about 40% the country's total production, and had increased Chile's world share as copper producer and exporter from about 22% to about 24% in 1994.

Trade

In 1994, Chile's total exports amounted to \$10.7 billion and total imports, \$10.8 billion, resulting in a negative trade balance of \$0.1 billion. In 1994, the contribution of the mineral sector exports to the total earnings was about 44.4%, of which copper, Chile's main export, was worth \$4.4 billion, or 36.7% of the total mineral exports. Other metallic minerals exports were valued at \$664 million (14%). Industrial minerals and others totaled \$157.8 million (3.3%).

Besides copper, Chile's main minerals exports were ferromolybdenum, gold and silver, iodine, molybdenum oxide, iron ore, iron pellets, sodium nitrate, lithium carbonate, nitrate, potash, precious metals, and zinc. CODELCO shipped 1.16 million metric tons (Mmt) of fine copper in 1994, 3.5% lower than in 1993, of which electrolytic copper; was 74%, fire-refined; 10.4%, blister; and concentrates 8.5%.

Revenues from copper sales by CODELCO in 1994 were \$2.58 billion, \$444 million more than in 1993. Revenues from byproduct sales during 1994 were \$418 million, \$65 million more than in 1993. The most significant byproduct was molybdenum, sales of which amounted to \$126 million for shipments of 15,950 mt, fine content. Doré metal sales were valued at \$93 million. The United States was Chile's principal trading partner, accounting for about 16% of Chile's imports and 23% of Chile's exports. According to the United Nations Statistical Office data, 1994 U.S. exports to Chile amounted to \$2.5 billion and U.S. imports from Chile totaled \$1.7 billion. According to COCHILCO, copper exports totaled \$4.4 billion, 33.9% higher than those in 1993. During 1994, foreign investment in mining surpassed public expectations reaching \$3.9 billion, of which \$1.8 billion materialized. Mining continued as the most attractive sector for foreign investment, contributing approximately 69.5% of the total achieved foreign investment in 1994. The positive impact of the startup of new copper projects also affected mineral exports. An increase of 32.1% were registered in copper exports in 1994, due mainly to an 88% increase in the price of copper and a 12% hike in quantity.

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: CODELCO; ENAMI; and Corporación de Fomento de la Producción (CORFO), which included Cía. de Acero del Pacífico, S.A. de Inversiones (CAP), Empresa Nacional del Petróleo, S.A., (ENAP), Empresa Nacional del Carbón S.A. Cía. Chilena de Electricidad, S.A. (CHILECTRA), Sociedad Química y Minera de Chile S.A.; and four regulatory agencies: SERNAGEOMIN, COCHILCO, the Foreign Investment Committee, and CONAMA.

CODELCO, the largest copper producer and exporter in the world, was composed of four divisions, Chuquicamata, El Teniente, Andina, and El Salvador, which produced more than 50% of all Chilean copper production in 1994. CODELCO was also a producer of gold, metal doré, molybdenum (trioxide, concentrate), and silver, as well as sulfuric acid and ammonium perrhenate (rhenium). ENAMI, the second largest state-owned company, 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 position, ENAMI

established as part of its mission the promotion, development, and processing of Chile's small- and medium-size nonferrous metals mines output. ENAMI 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-size miners. Furthermore, ENAMI produced, sold, and distributed sulfuric acid; participated with private investors in the development of small- and medium-size mining projects; guarded against potential environmental harm from mining production; and bought ores for flotation and leaching at its own plants.

The total labor force, including staff and office personnel working directly in the minerals sector, numbered 78,000, representing about 2.3% of the total labor force (4,728,000) in the country. The metals sector's labor force was 61,000, about 79% of the mineral sector labor force total, of which 47,000 were copper workers. The industrial minerals sector labor force was 3,400, and the mineral fuels sector was 13,000, of which 85% were coal miners. CODELCO employed about 39,000 people, including its own copper workers and contractors' personnel in 1994, or about 50% of the total metals sector employees.

Commodity Review

Metals

Copper.—Chile's increased copper production in 1994 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 2.22 Mmt of copper in 1994. The increase in copper production of 8.0% from that of the previous year was due to the additional output from the new private sector's La Candelaria, Quebrada Blanca, and La Escondida Mines that produced about 480,000 mt, an increase of 16%. CODELCO's copper production decreased by only 0.5% in 1994 compared with that of 1993, owing to the decline in the average grade of copper from 1.25% in 1991 to 1.15% in 1994, and the lower volume of ore treated in the Chuquicamata and El Salvador Divisions. World prices for both copper and precious metals were up in 1994. CODELCO's investments in 1994 were \$374.1 million, 8.9% less than in 1993, and were chiefly directed toward developing the corporation's productive capacity and resolving its environmental problems. During 1994, CODELCO contributed \$858 million to the national treasury, an increase of about 105% compared with 1993 payments.

Among other investments were the El Abra deposit,

Radomiro Tomic Mine, and the Andina expansion project. Construction of these three projects was scheduled to begin in 1995. The CODELCO Board of Directors approved a new, less favorable deal for the joint development of the El Abra copper deposit with U.S.-based Cyprus Amax Minerals Co. and reached a new agreement in May reflecting the apparently lower value of the deposit. Cyprus' upfront payment was reduced from \$404 million to \$340 million. Negotiations related to the El Abra deposit concluded in May and June. With a useful life of about 17 years, the project called for annual production of 225 Mmt of electrolytically obtained copper cathodes. The total investment, including working capital and others, amounts to \$998 million. Startup was scheduled for late 1996. A significant part of this investment, unlike those in previous years, has been channeled into intensified environmental cleanup plans.

Chuquicamata output reached 606,211 mt of fine copper in 1994, 1.7% less than that of the previous year, or 53.5% of the total copper produced by CODELCO. CODELCO's other three mine outputs were as follows: El Teniente, 309,000 mt; El Salvador, 83,000 mt; and Andina, 136,000 mt.

Under study by ENAMI were the following two projects, one of which was the feasibility study for the modernization of Las Ventanas and Paipote smelters as well as for the northern part of the Pacific Smelter and Refinery (Fundicion y Refineria del Pacifico). The feasibility study began in 1991 at a cost of about \$850,000. The participation of ENAMI in the partnership for the Fundicion y Refineria del Pacifico, along with Lac Minerals, Arbi Participacoes, Acec Union Minerie, and South Metal Chile, sought to stimulate the development of additional smelting and refining business with the participation of private capital to increase the value added of Chile's exports, making the best use of the availability of concentrates in Chile. ENAMI was developing an environmental protection plan including installation of a modified El Teniente- Type Converter and a new electric furnace at Las Ventanas smelter; startup of a sulfuric acid plant in Las Ventanas, permitting a 30% reduction in gaseous emissions and a 60% in particulate; and investment of a \$14 million oxygen plant to produce 300 mt/a of SO₂ delivered to the smelter for concentrate treatment.

RTZ Corp. Plc. of the United Kingdom reported a problem with commissioning the ammonia leach processing plant at the site, currently operating at 50% of design capacity; it was expected to be working at full capacity by midyear 1995. Copper production at Escondida, 30% owned by RTZ, had been rising steadily since the mine was started up in 1990 from 320,000 mt/a to 480,000 mt/a in 1994. Phase three expansion at Escondida, due for completion in 1996 at a cost of \$520 million, should increase production to 800,000 mt/a at its solvent extraction electrowinning (SX-EW) cathode plant. The new facilities, built near the port of Coloso 14 kilometers (km) from Antofagasta, incorporate an ammonia leaching process developed by BHP, one of the partners in the joint venture.

Exxon's Disputada de las Condes in 1994 had a combined

copper production from its El Cobre and Los Bronces Mines of 150,500 mt (up from 148,200 mt in 1993). Output in 1995, therefore, was expected to reach 200,000 mt/a of copper in concentrates after the new 37,000-metric-ton-per-day (mt/d) Las Tortolas concentrator and 56 km of slurry pipeline under construction is fully completed, with 130,000 mt/a slurried ground ore coming from the expanded Los Bronces operation and 70,000 mt/a from El Cobre Mine. Because the ore averaged 0.016% molybdenum, Exxon planned to build a molybdenum recovery plant and was in the process of investing \$180 million on modernizing and expanding the Chagres smelter by the addition of a flash smelter. To handle this, the acid plant capacity was increased from 66,000 mt/a to 300,000 mt/a. On completion of this investment, the smelter would be able to produce 125,000 mt/a of blister copper.

Empresa Minera Mantos Blancos, S.A.'s new Mantoverde SX-EW project 85 km southeast of the port of Chanaral, was based on sea water leaching of 5.4 Mmt of 0.9% copper oxide ore from an open pit mine and would produce 53,500 mt/a of copper cathodes.

The Anglo American Corporation of South Africa, which controlled Minorco and Mantos Blancos, acquired a one-third interest in the Collahuasi copper project in northern Chile from Chevron Corp. of San Francisco, California, for \$190 million. The two Anglo American companies formed a new entity, Minera/Mantos Minorco, to complete the acquisition. Collahuasi has the potential to produce more than 300,000 mt/a of fine copper with an estimated investment of \$1 billion. The other two partners in the project are Falconbridge Ltd. of Toronto, Canada, and the Shell Group of the Netherlands. The property consisted of two deposits, Ujina and Rosario. The Ujina deposit, totaling more than 100 Mmt and grading an average 2% copper, would be processed through a heap-leaching and SX-EW plant with startup slated for 1997. Mantos Blancos sold its copper deposit, "Lomas Bayas" in Sierra Gorda (Region II), to Gibraltar Mines, a Canadian mining company, for \$19 million in November.

Bechtel-Chile started a feasibility study on the Mantoverde copper deposit in 1993. The deposit was estimated by the company to have reserves of 93 Mmt grading 0.82% copper and was expected to be in production by yearend 1995.

Compañía Minera Ojos del Salado S.A., a subsidiary of Phelps Dodge of the United States, was negotiating to use CODELCO's port installations at El Chanaral to ship copper concentrates from the Ojos del Salado deposit and from the main Candelaria ore body. Ojos del Salado inaugurated a major expansion of its facilities in Tierra Amarilla in November, doubling capacity to 3,500 mt/d at a cost of \$20 million. This was expected to raise output in 1994 to 23,000 mt/a of copper, up from 11,500 mt/a in 1993, and to 75,000 mt/a by early 1995. The copper was to be shipped out in the form of concentrates.

La Candelaria, owned 80% by Phelps Dodge and 20% by Sumitomo, Corp., of Tokyo, Japan, began its trial run in August 1994. The official startup of operations was planned

for March 1995. The plant was scheduled to process some 28,000 mt/d of ore, producing 125,000 mt of copper in concentrate (30% copper content) and more than 2,532 kg of gold per year. La Candelaria partners have invested \$560 million opening the mine and constructing the plant and new port facilities at Caldera. Expansion plans were under consideration and a decision to possibly double production would be made in 1995. Candelaria had an investment approval from the Government of Chile for \$1.5 billion, the third-largest ever, after seeking funds from Far Eastern and European sources. Sumitomo, the world's largest copper trader, agreed to take a 20% ownership stake in La Candelaria for \$40 million and support its share of debt financing. The Overseas Private Investment Corp. (OPIC), a U.S. Government insurance agency, awarded a \$50 million loan to La Candelaria. In addition, La Candelaria was expected to obtain risk insurance coverage for \$100 million from OPIC. La Candelaria is near Copiapo on the southern edge of the Atacama Desert. The mine began production in July 1994. It has estimated reserves of 366 Mmt with an average grade of 1.29% copper and 0.26 gram per meter ton (g/mt) of gold and 4.5 g/mt of silver. The mine had an expected lifespan of 34 years, and when completed, would represent the biggest new copper investment since BHP-Utah's La Escondida Mine was inaugurated in early 1991.

Other copper projects included Quebrada Blanca, in northern Chile in Region I³, about 170 km southeast of Iquique, at 4,300 meters (m) above sea level. The deposit was owned by Compania Minera Quebrada Blanca S.A., a joint venture of Cominco Ltd. of Canada (38.25%), Teck Resources Int. Ltd. (29.25%), Cominco Int. Ltd. (9.0%), ENAMI (10%), and Sociedad Minera Pudahuel Ltd. (13.5%). Quebrada Blanca reserves were estimated at 90 Mmt of copper with an average grade of 1.3% in its secondary enrichment zone, enough to keep the mine in operation for 14 years. An additional 400 Mmt of copper sulfide ore with an average grade of 0.5% also was reported, but mining of this ore was not presently economical. The mineral was being processed by heap leaching using the bacterial leaching techniques patented by Sociedad Minera Pudahuel. The project started on September 8 and was expected to produce approximately 75,000 mt/a of fine copper. Cominco management stated in 1994 that it had obtained financing and was moving forward with construction of the project, which entailed an investment of \$400 million to develop the project. Cominco directly financed \$110 million and the rest was raised in international capital markets.

Compañía Minera Cerro Colorado, S.A., the Chilean subsidiary of Río Algom Ltd., of Vancouver, Canada, completed a partial financial package of \$150 million for the copper project east of Iquique, high on the northern plateau. The Nippon Mining Company Ltd. of Japan, first explored the Cerro Colorado copper deposit in Region I between 1975-80. Although the original project was based on the flotation of sulfide ores, the Río Algom project was based on bacteria heap leaching with sulfuric acid. Río Algom Ltd. raised copper reserves at its Cerro Colorado copper mine by

90% to 193 Mmt of estimated reserves with an average grade of 1.08% copper. The increased reserves were based on an assessment of additional drilling and delineation of reserves. The project was expected to produce 20,000 mt of copper cathodes in 1994 and 45,000 mt in 1995. The mine would be open pit using the bacteria heap leaching and the SX-EW process. Production was to begin in 1994. Total planned investment was estimated at \$290 million.

The Compañía Minera y Exploradora Doña Inés de Collahuasi Ltda., owned by a consortium of Falconbridge International Inc. of Canada; the Shell Group of the Netherlands; and Chevron Corp. of the United States, completed in 1993 a massive 40,000-m exploration drilling program aimed at mapping out one of the most promising ore bodies in the Andes. Collahuasi is 4,500 m above sea level on the Tarapaca plateau, 170 km southeastern from Iquique, in the vicinity of Quebrada Blanca and Cerro Colorado. In September 1993, Collahuasi decided to focus its exploration in and around the Rosario, Ujina, and Huinquentipa areas. Reserves at Rosario, its main deposit, were estimated to contain at least 800 Mmt of primary ore with an average grade of 0.8% copper and 25 Mmt of secondary ore grading 1.7% copper. The Ujina reserves surpassed 500 Mmt with about the same grade ore as Rosario. The project was established on a minable resource of 30 to 40 Mmt of oxide and enriched sulfides aimed at producing 80,000 mt of copper. That alone would have meant an investment of \$250 to \$300 million, similar to the nearby Quebrada Blanca project. The total production for the project was estimated to be about 300,000 mt/a of copper in concentrates plus an additional 50,000 mt/a copper cathodes by 1999.

RAYROCK Yellowknife Resources Inc. of Toronto, Canada, expected to conclude a \$20 million financing package for Ivan-Zar, a copper project 35 km northeast of Antofagasta. Ivan-Zar is an SX-EW project from which production in the first stage would be 8,000 mt/a of copper cathodes. This is one of a number of small-sized copper deposits to come on-stream in the mid-1990's. Commercial production at Ivan-Zar was to commence by late 1993.

The copper deposit Zaldivar, in Region II, north of the Escondida at 3,250 m above sea level and about 200 km southeast of Antofagasta, was owned by Cia. Minera Zaldivar S.A., a 50-50 subsidiary of Placer Dome Inc. of Canada and Outokumpu Copper Resources Chile B.V.

Compania Minera Lince Ltd. began commercial production of copper cathode in December 1993, after successfully starting up its crushing circuit. The project used an innovative seawater heap-leaching technology. Investment was estimated at \$62 million. Output was to be 20,000 mt/a of copper cathodes.

Gold and Silver.—Among the gold-producing companies in Chile, the El Indio Mine remained the largest. It was owned by Barrick Gold Corp. of Canada, which acquired the properties from Lac Minerals Ltd. also of Canada in 1994. Barrick Gold Corp. expected to spend about \$500 million to develop its rich El Indio gold projects in Chile. Barrick was

expected to spend about \$200 million in 1995 on the El Indio and the El Tambo Mines and finalize the feasibility study of its Nevada gold project in Chile. Barrick Gold Corp. also planned to spend two-thirds of its \$100 million exploration and development budget in Latin America, mainly at El Indio but also on the Cerro Corona copper project in Peru.

El Indio was followed by La Coipa Mine, owned by Dayton Development Corp., Placer Dome, and TVX Gold of Canada. Other precious metal producers included Choquelimpie (Vilacollo), El Hueso (Homestake), San Cristóbal (Niugini), and La Escondida, El Bronce de Petorca, and El Guanaco project owned by AMAX Gold Inc. The largest producer of silver in Chile was the La Coipa Mine with silver as a byproduct of gold production. La Coipa's silver output was about 430,000 kg in 1993, 43.7% of the country's total output. La Coipa, operated by Cia. Minera Mantos de Oro Ltda., was operating at its full capacity of 15,000 mt/d of ore by yearend 1994. Followed by CODELCO, other important producers of byproduct silver were El Indio, La Escondida, and El Bronce de Petorca. Niugini heap-leach operations contributed 1,700 kg of gold in doré bars. CODELCO maintained its level of output of gold at about 2,200 kg in 1994 as a byproduct of its electrolytic copper refining.

SCM Vilacollo Ltd., 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 Ltd. and Cia 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., ore extraction at El Refugio would require an open pit with a stripping ratio of 1:1. The study recommended a plant with a processing rate of 33,000 mt/d. At that rate, Bema Gold Company would produce 7.2 mt/a of gold for 13 years.

Gold production from the Can Can deposit in Northern Chile was 1,900 kg of gold in 1994. Developed at a capital cost of \$12 million, the deposit was expected to eventually produce more 2,000 kilograms per year (kg/a) of gold and about 4,000 kg/a of silver with an expected mine life of 6 years. Cia. Minera Can Can S.A. was owned 60% by Compania de Carbones de Chile S.A. (COCAR) and 40% by other Chilean investors.

Iron Ore, Manganese, and Steel.—In 1994, Chilean iron production and exports recovered 8.4% to 7.6 Mmt and 5.8% to 6.6 Mmt, respectively. In 1994, pellet production was 3.3 Mmt, similar to the year before. The Algarrobo Mine output, which feeds the pellet plant, would be depleted by the end of this decade. Cia Minera del Pacifico S.A., the owner, was expected to decide in 1995 whether to open a new deposit, Los Colorados East, by 1998 to maintain the level of output. Mitsubishi Corp. of Japan and its long-term Chilean partner, Cia de Acero del Pacifico S.A. (CAPSA), were to invest \$107 million in an expansion of CAP's Colorado iron ore mine in the north of the country. CAP is

currently producing around 1 Mmt/a of iron concentrate from the deposit, and the project aimed to increase output by mid-1998. Mitsubishi was to supply all the investment required for the expansion program, while CAP would contribute the mining rights and other assets to the equally held joint venture. Manganesos Atacama, S.A. (MASA), a subsidiary of CAP, a Swiss-Chilean industrial group, 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 a plant in Coquimbo. 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 1.0 Mmt in 1994, the same as in 1993. CAP reported that in order to increase the production capacity at its Huachipato smelter and reduce operating costs, the holding company was considering an investment of \$350 million to modernize the plant between 1994-98. In the last quarter of 1993, CAP reported that the costs at the Huachipato smelter decreased about 2% compared with the same period of 1992 and that it was one of the few smelters in the world to operate at a profit.

Lead and Zinc.—Lac Minerals-owned Sociedad Contractual Minera el Toqui (SCMT) in Chile continued production despite problems resulting from low zinc prices. El Toqui, Chile's largest zinc miner, produced some 57,000 mt of concentrate in 1994 containing 28,000 mt of zinc. A temporary shutdown of El Toqui's zinc operations would cost the company some \$5 million, so Lac opted for continued production while at the same time reducing costs at the 1,500 mt/d concentrator at Coyhaique in the far south of Chile. Production of zinc increased 5.2% in 1994 to 30,968 mt, of which 91% was from SCMT. Lac completed an expansion program in 1993, which was largely responsible for the notable increase in Chilean zinc production for the past 3 years. However, low zinc prices have induced Lac to postpone its plans to expand its El Toqui zinc mine near Coyhaique.

Industrial Minerals

Lithium and Potassium.—Chile was the second largest producer of lithium in the world after the United States. Production of lithium carbonate in 1994 was estimated to be 10,400 mt, slightly above that of the previous year. Sociedad Quimica y Minera de Chilena S.A. (SQM), the private nitrate and iodine producer, announced investment plans totaling \$230 million for the next 4 years. This investment followed \$60 million in 1994, focusing primarily on the Minsal project on the edge of the Atacama salar and a new potassium nitrate plant at Coya Sur, just south of Maria Elena in Region II inaugurated in October. The new plant added a productive capacity of 100,000 mt of potassium nitrate to SQM's previous 260,000 mt. The plant, which

cost \$13 million to construct, would produce technical-grade products for industrial and agricultural use. The first phase of the Minsal project would require a \$75 million investment and have a production capacity of 300,000 mt of potassium chloride. At present, SQM spends some \$35 million on imported potassium chloride for use in potassium nitrate production.

Nitrates and Iodine.—Cia Minera Yolanda S.A, a Chilean subsidiary of KAP Resources Ltd. of Canada, in the Taltal zone of Region II, was planning to produce roughly 300,000 mt/a of sodium nitrate, 357,000 mt/a of potassium nitrate, and 180 mt/a of iodine using heap-leaching methods by utilizing seawater and solution concentration by solar evaporation in ponds before crystallization. The company planned that part or all of the sodium nitrate produced would be converted to potassium nitrate, utilizing an additional potassium chloride treatment and recrystallization, and iodine would be extracted from the residual waters. The required investment was estimated at \$41 million, which would be financed by four banks in addition to the Inter-American Investment Corp. KAP expected that once the capital was available, the Yolanda project could start production by 1996. The Yolanda project included a strategical partnership with Canadian producers of potassium chloride, to which would be offered the marketing of the potassium nitrate.

KAP Resources Ltd. entered into a 50-50 joint venture with Atacama Resources, Ltd., known as the Taltal Joint Venture, in which North Lily Mining Co. of Canada, was retained as the operator and would receive a 10% share in the profits.

The COSAYACH project, owned by Cia. de Salitre y Yodo de Chile, planned to develop and produce potassium nitrate and iodine from existing reserves in the Pozo Almonte Zone (Region I) based on material already removed during the past "salitre" nitrate exploitation. The project proposed to extract 2.5 Mmt/a of caliche by heap-leaching methods and concentration by solar evaporation. The company estimated that production would reach 205,000 mt of potassium nitrate and about 1,000 mt of iodine. The investment required could reach \$28.4 million. The company had a production capacity of 300 mt/a of iodine. The implementation of the current project was still under study. The SORONAL project contemplated the reopening of the current operations at Pedro de Valdivia and Maria Elena of SQM. This "salitre" field, south of Iquique, had 500 Mmt of caliche with a grade of 9% sodium nitrate and 500 parts per million of iodine. The process was based on heap leaching and concentrate in solar evaporation ponds. Both the Yolanda and Cosayach projects will increase Chile's production of nitrates by 500,000 mt/a above the current level 850,000 obtained by SQM.

During the first quarter of 1995, SQM intended to tender for detailed engineering for production of lithium at its Minsal project on the Salar de Atacama. SQM expected to invest about \$40 million in the project to produce 75,000 mt/a of lithium carbonate. Plant construction was to be

contracted in 1995 and begun in 1996-97 in order to commence production in 1997-98.

CORFO, a holding company for state enterprises, announced in January 1995 that it would auction off its 18.2% share/interest of the Minsal project in March. SQM was reportedly interested in increasing its ownership to 100% by buying CORFO's share, but at least one other group, a U.S. consortium, was also interested. CORFO expected to realize \$7 to 10 million from the sale.

Sulfur.—Chile has been an importer and producer of sulfur for many years. In 1994, Chile imported about 42,000 mt of sulfur, 27.5% more than that in the previous year, mostly from Bolivia, Canada, and the United States, valued at \$2.5 million. Chile's native sulfur production derived from caliche decreased almost 96% to 937 mt. Chile's total production of sulfur, including sulfur derived from smelters and oil refineries, as well as imported, was directed to the manufacture as raw material to produce sulfuric acid in various industrial plants spread from Regions I through VIII. About 94% of the acid was used in mining and metallurgy. The balance, around 10,000 mt, was applied mainly as a fungicide. Condesa Mining Corp. of the United States received authorization from the Foreign Investment Committee to carry out at \$25 million development in two sulfur mines near San Pedro de Atacama with a capacity to treat 1,000 mt/a. The project would include construction of a concentrating plant, a refining plant, and a pipeline to the port of Coloso, south of Antofagasta. No startup date had been reported.

Chuquicamata, as part of a \$323 million investment to reduce SO₂ emissions by a third, added a new 620,000 mt/a acid plant (number 4) to replace the 180,000 mt/a old number 1 plant, for a total production of 1.3 Mmt. Meanwhile, Refinadora Metalurgica (Refimet) would produce 90,000 mt/a of acid in its new copper smelter. Consumption of sulfuric acid in Chile amounted to 900,000 mt/a. Startup of new sulfuric acid plants using gases from the smelters would increase CODELCO's production of more than 1.8 Mmt/a. As a result, Chile would significantly lower sulfur imports. Sulfuric acid also was produced from gases from four copper smelters: Chuquicamata, Las Ventanas, Paipote (Hernan Videla Lira), and Chagres. These plants have a production capacity of 2.0 Mmt/a, of which 1.3 Mmt/a was from Chuquicamata; 290,000 mt/a from Las Ventanas; 60,000 mt/a from Paipote; and 330 mt/a from Exxon's Chagres smelter to replace its old 70,000 mt/a facility. Also, about 20 smaller sulfuric acid plants between Arica and Rancagua were using sulfur as raw material. The capacity of these plants totaled approximately 500,000 mt/a.

Mineral Fuels

Coal.—Bituminous coal output in 1994 was reported at 1.7 Mmt. The Chilean Government has encouraged greater domestic coal production as a means of reducing Chile's 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 COCAR, which strip-mined subbituminous coal in Pecket, near Punta Arenas. It was reported that COCAR was still considering a number of plans for future coal output. Its current production from the Pecket Mine was 1.2 Mmt/a. 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 mt/a. However, Tocopilla was taking all Pecket's output. Additional potential power stations projects for later this decade included 150 megawatt (MW) plants at Huasco and Tocopilla and a 400 MW facility in the north of the country. By the end of the 1990's, these could increase total coal demand to 4.5 Mmt/a. COCAR was examining a number of options. Pecket could be expanded by moving into an underground operation and it has been reported that prefeasibility studies have examined the development of a further 100 Mmt of reserves at Pecket for an output of 1 Mmt/a. The second possibility was to develop the Isla Riesgo deposit, which would be an open pit, some 40 km from Pecket Mine.

The large number of direct electrowinning copper projects in the north of Chile will require new powerplants, which should come on-stream in the next 3 to 5 years. They include power unit 16 in Tocopilla to supply Chuquicamata's plant expansion; a grassroots unit in the iron ore port of Huasco, funded by CHILGENER, CAP, and COCAR, operated as a joint venture named Guacolda, to supply Phelps Dodge's Candelaria expansion and all the new precious metal mines in the Atacama District; and a third unit that probably would be built in Mejillones, north of Antofagasta, essentially to supply Escondida's expanding needs.

COCAR, at its Pecket strip mine, would have to double its capacity to supply the additional demand for an output of 1 Mmt/a. Bituminous coal was found in underground deposits in Region VIII. Operations were carried out in this area by the state-owned ENACAR that produced around 800,000 mt/a, with Carbonifera Schwager contributing 340,000 mt/a. In all, they represented an approximately 75% of all coal produced in the Region. The Chilean state holding group CORFO was promoting the sale of its Riesco Island subbituminous coal deposit in the extreme south of the country. Plans were made to develop a 3 Mmt/a open pit mine, but CORFO wanted to transfer the asset to a private company for development. Initial costs have been estimated at some \$70 million.

Natural Gas.—The principal natural gas reserves of the country were found in the Magallanes Basin, in the far south of Chile. Natural gas production decreased slightly to 4,150 million cubic meters (Mm³) continuing the declining trend since 1990. Of the total production, about 51% was reinjected and 49% was marketed internally. The natural gas

that was reinjected by ENAP in the straits of Magellan Region in the past were to be used to produce 150,000 mt/a of ammonia and 570,000 mt/a of urea at Cabo Negro. During 1994, 55% of the natural gas was produced from offshore, 23% from onshore, and 22% from Tierra del Fuego.

The Trans Gas (Gaseoducto Transandino/Gas de Chile) consortium announced that the tariffs it would apply to 12 companies that participated in the "open season" process for the supply of natural gas from the Loma de La Lata gasfield in the Argentine province of Neuquen would be on average 24% lower than the competing Gas Andes consortium. The announced tariffs were \$0.76 per million British Thermal Units for Region VIII; \$0.79 for Regions VII, VI, and south of Santiago; \$0.93 for Metropolitan North; and \$0.96 in Region V. The reason for the difference of more than 20% in tariffs between the two consortiums is fundamentally geographic. The total distance of the Trans Gas pipeline from the deposit in Neuquen via Concepcion to Santiago is 797 km, while the Gas Andes pipeline, which comes north from Neuquen, Argentina, through Mendoza and then to Santiago, is 902 km.

According to industry sources, the Trans Gas consortium needed to have supply contracts with at least three electric generating centers, one of which must be either Endesa or Colbun. The Gas Andes project, on the other hand, required contracts with six centers to make it feasible. Construction of a 1,200-km gas pipeline between natural gasfields in southern Argentina and Santiago was coming closer to reality as negotiations progressed. The \$1 billion trans-Andean pipeline was being negotiated by a consortium formed by Chiletra and ENAP (Chile), Italgas and Snam (Italy), and Enagas (Spain). Construction was expected to start in 1993, and the pipeline was scheduled to be completed in early 1996. Prefeasibility studies for the pipeline have been completed.

Gas Sur had applied for a concession to transport natural gas via pipeline from Neuquen, Argentina, to Region VIII. The Gas Sur consortium was made up of the Canadian Novacorp Group, Lone Star of the United States, and the Chilean companies Gasco and Copec. Gas Sur estimated it would invest between \$95 million and \$139 million in the construction of the pipeline and a network of 400 km between Neuquen and Concepcion, including the construction of a thermo-electric generating center. The gas pipeline could be operating in 1997 and would allow open access to customers wanting to be directly supplied with gas from Argentina.

Because ENAP's natural gas production from southern Chile has been committed as raw material for an existing methanol plant there, as well as a future ammonia/urea complex, a natural gas pipeline was under construction from Argentina gasfields to supply natural gas to central Chile. The country also planned to import natural gas from neighboring countries to the north (Argentina and Bolivia) to supply natural gas for the large mining activities in the north of Chile.

Petroleum.—Chilean production of crude oil sustained a further decrease of 2% in 1994, to 5.1 million barrels (Mbbbl). Imports of crude oil in 1994 were 43.3 Mbbbl compared with 39.1 Mbbbl in 1993. The new 105,000 barrels per day (bbl/d), 450 km oil pipeline from the southwestern Argentina province of Neuquen to the Chilean port of San Vicente on the Pacific Ocean was expected to be opened late in 1994. The most important private infrastructure project so far in the Southern Cone region of South America, the pipeline 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 Trasandino S.A. a company formed by Chile's state oil company ENAP and Argentina's Yacimientos Petroliferos Fiscales (YPF) and Banco Rio de La Plata (Argentina). Banco Rio de La Plata provided all the credit for the project in the form of medium-term loans that will be refinanced as long-term credits with other banks. YPF held 57.75% of the shares; Banco Rio de La Plata 30%; and the balance by ENAP. The pipeline, scheduled to be completed in March 1994, would transport crude oil from Argentina's Puesto Hernandez oilfields to Chile's terminal in Talcahuano. Plans called for about 94,000 bbl/d of petroleum to be pumped into Petrox's terminal. Petrox was expected to process 37,700 bbl/d and the remainder was to be shipped from Port of San Vicente to Chile's Concon refinery.

Sipetro S.A. ENAP's international subsidiary was scheduled to start production of crude oil in the Magellan A field in Argentina's waters near the Strait of Magellan by yearend 1994. The \$170 million joint-venture project between YPF and Spitrol would produce about 14,000 bbl/d of crude. By yearend 1994, the company was in the process of installing four platforms in the Magellan A area. The total production of crude would go to ENAP. The YPF percentage share in the venture would be kept as part of its payment. ENAP reported \$100 million profit in 1994 as a result of a 25% increase in output to 1 Mm³ of crude from the Strait of Magellan. The Petrox and ENAP refineries contributed \$65 million and \$27 million, respectively, to ENAP's total profit.

Reserves

Mainly a copper producing country, Chile also produced gold, molybdenum, rhenium, silver, sulfuric acid, and other elements as byproducts of copper mining and processing. CODELCO produced more than 51% of the total copper in the country and held more than 9 billion mt of copper reserves with an average ore grade content of nearly 0.9%, or the equivalent of more than 70 years of production at present levels representing about 20% of known global reserves. Its molybdenum production reached 15,950 mt in 1994, making CODELCO the world's second most important producer. Confirmed copper reserves at the EL Abra deposit are 669 Mmt of copper oxide with an average ore content of 0.6% copper and 523 Mmt of copper sulfide grading 0.6% copper.

Some of the private sector's reported copper reserves, listed as estimated figures and average grades, respectively, were as follows: Escondida, 1,800 Mmt, 1.6% copper; Cerro Colorado, 105 Mmt, 1.3% copper; Quebrada Blanca, 85 Mmt of 1.3% copper and 250 Mmt of 0.5% copper; Zaldivar, 316 Mmt of 0.9% copper and 680 Mmt with 0.6% copper. Collahuasi deposit had three areas with the following reserves and grades: Rosario, 800 Mmt of 0.8% copper and 0.25 Mmt of 1.7% copper; Ujina, more than 500 Mmt of 0.8% copper and 200 Mmt of 1.6% copper; and Huiniquintipa, 7 Mmt of 1.2% oxide copper. La Candelaria reported more than 360 Mmt of ore reserves grading 1.09% copper and 0.25 g/mt of gold; Andacollo, more than 25 Mmt grading 1.3 g/mt of gold and 250 Mmt grading 0.6% copper; Manto Verde, 93 Mmt grading 0.82% copper; and El Refugio, 112 Mmt grading 1 g/mt of gold containing about 90 mt of gold. Current reserves at El Indio were estimated at about 249 mt of gold, and held about 368 mt of mineral resources as stated by Lac Minerals Ltd. The El Can Can deposit had proven reserves of 1.2 Mmt of ore grading 8 g/mt of gold and 60 g/mt of silver. However, potential resources could reach 5.5 Mmt of ore. It came on-stream in 1994 at a production of about 160 kg month of gold.

The Colorado iron ore deposit contained some 245 Mmt of minable ore, forming the basis for a 20-year project life and feeding Compania Acero del Pacifico's 4 Mmt/a pellet plant.

Infrastructure

Chile extends approximately 4,200 km along the Pacific Coast of South America and has an average width of approximately 180 km between the coastline and the Andes Mountains. Chile is divided into 13 regions, including the Metropolitan region, which is not numbered like the other 12 regions, beginning with Region I at the northern border with Peru and continuing in sequence to Region XII at the southern end, with each region having a capital. Chile has three main geographical areas that vary dramatically in climate, resources, and population. The northern area from Region I to Region IV includes the Atacama Desert, one of the world's driest areas. Farming is limited to a few areas that can be irrigated. However, abundant and varied mineral and energy resources are in this area. Its vast reserves of copper, iron ore, nitrates, and lithium carbonate constitute a major asset to the Chilean economy. Continuing south from Region V to Region X is the central area, where 90% of the population resides. The Andes compose one-third to one-half of the middle Chile area. Near the northern end of the valley lies Santiago, Chile's capital and home to about one-third of the country's population. Industrial resources include large copper deposits, as well as coalfields and hydropower.

The southern Chile area from Region XI to Region XII is one of the wettest and stormiest parts of the world. Less than 2% of the population resides in this area. Southern Chile's resources are concentrated in the area lying east of the mountains. These natural resources include coal, natural gas,

and petroleum.

The railway system of Chile served all the important industrial, mining, and agricultural areas from Region I (Iquique) to Region X (Puerto Montt) for a total of 8,613 km. The pattern of Chile's highways was similar to that of its railways. The road system totaled 79,025 km, of which 9,913 km was paved, with most of the remainder of secondary quality.

International trade of mineral commodities, chiefly copper and its byproducts, was handled through the ports of Arica, Antofagasta, Valparaiso, Tocopilla, Cruz Grande, Talcahuano, and San Antonio, which handled almost 60% of the total tonnage.

Crude oil, refined products, and natural gas were transported to consumption centers by three major pipelines that are 785 km, 755 km, and 320 km in length, respectively. In addition, a 450-km, 41-centimeter diameter oil pipeline was expected to transport crude oil from Argentina's Puesto Hernandez oilfields to Chile's Talcahuano terminal in the near future, and a 1,200-km natural gas pipeline between gasfields in southern Argentina and Santiago was coming closer to reality as negotiations continued to show progress.

Outlook

Chile continues to be an outstanding example of how free trade policies and promotion of foreign investment can generate economic growth in Latin America. The country is attractive as an investment center, especially for export-related activities. The current prosperity of Chile is based on free-market initiatives and a stable political system. A record \$4.66 billion was posted during 1994 for achieved foreign investment, an increase of 70.1% from 1993, according to Chile's Minister of Economy and Executive Vice-President of the Foreign Investment Committee. Of the total of achieved foreign investment, \$2.53 billion entered the country through its Foreign Investment Statute (D.L. 600), \$407.1 million through Chapter XIV of the Central Bank's International Exchange Norms, and \$1.72 billion through issues of American Depository Receipts in 1994. The amount entering through Chile's D.L. 600 marked a 47.7% increase from the previous year's figures and was divided into \$1.56 billion of direct capital investment, and \$971.3 million in associated credits. The three primary destinations of achieved direct investment (D.L. 600) in 1994 were mining, with \$1.76 billion (70%); followed by industry, \$320.7 million (12.7%); and services, \$314.4 million (12.4%). Furthermore, officials highlighted the fact that approximately 80% of the total was directed outside of Chile's Metropolitan Region.

In 1994, Chile was to begin negotiations with Canada, Mexico, and the United States to be admitted into the North America Free Trade Agreement (NAFTA). Chile had organized a commission composed of mining-related professionals under the direction of the current Minister of Mines and coordinated by the Ministry of Finance to study and coordinate the main mining-related subjects in NAFTA.

Chilean mining activities were concentrated in five mineral groups: coal, copper and its byproducts; industrial minerals; iron and steel; and precious metals. Chile's annual copper production was expected to grow from 2.06 Mmt in 1993 to about 3.5 Mmt by the year 2000, an increase of nearly 75%. Gold was projected to increase from about 33,900 kg to 43,800 kg by 1996, representing an increase of nearly 30%, and silver was projected to decrease from 1,030,000 kg to about 960,000 kg during the same period.

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

In the energy sector, coal production declined from 1.8 Mmt in 1993 to 1.7 Mmt in 1994. The Pecket coal mining project and the Isla Riesco project 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.

The main foreign investment projects in copper mining in Chile through 1998 include Cerro Colorado, Quebrada Blanca, Collahuasi, El Abra, Ivan-Zar, Zaldivar, Escondida (expanded electrowinning and concentrate), Manto Verde, and Candelaria.

The major current foreign investment projects in precious metals mining and other minerals in Chile are Guanaco, Refugio, Andacollo, Fachinal, Nevada, Tambo, La Coipa, La Pepa, and Yolanda.

²Where necessary, values have been converted from Chilean pesos (Ch\$) to U.S. dollars at the rate of Ch\$415=US\$1.00, the average exchange rate for 1994.

³Chile's geographic regions are more fully described in the infrastructure section of this report.

Major Sources of Information

Ministerio de Minería

Teatinos 120 Piso 9, Casilla 54, Correo 21
Santiago, Chile
Telephone: 56-2-6714373; 56-2-6986593
Fax: 56-2-6989262

Comision Chilena del Cobre (COCHILCO)

Agustinas 1161 Piso 4, Casilla 9493
Santiago, Chile
Telephone: 56-2-6726219
Fax: 56-2-6723584

Servicio Nacional de Geología y Minería (SERNAGEOMIN)

Ave. Santa María 0104, Casilla 1046
Santiago, Chile
Telephone: 56-2-6375050
Fax: 56-2-6372026

Major Publications

COCHILCO: Estadísticas del Cobre y otros Metales.
CODELCO: Annual.

¹Text prepared Sept. 1995.

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

(Metric tons unless otherwise specified)

Commodity 3/ METALS	1990	1991	1992	1993	1994 e/
Arsenic trioxide	5,830	6,820	6,020	6,200 e/	6,300
Copper:					
Mine output, Cu content 4/	1,590	1,810	1,930	2,060	2,220 5/
Metal:					
Smelter, primary 6/	1,330	1,300	1,330 r/	1,390 r/	1,460
Refined: 7/					
Fire primary refined	134 r/	144 r/	122 r/	134 r/	135
Electrolytic	1,060 r/	1,080 r/	1,120 r/	1,130 r/	1,140
Total	1,190	1,230	1,240	1,270	1,280
Gold, mine output, Au content	27,500	28,900	33,800	33,600 r/	38,800 5/
Iron and steel:					
Iron ore and concentrate:					
Gross weight	7,900	8,690	7,640 r/	7,010 r/	7,600 5/
Fe content	5,040 e/	5,820	5,120 r/	4,390 r/	4,300
Metal:					
Pig iron	675	703	873	917	900
Ferroalloys:					
Ferchromium	1,870	2,510	2,110	680 r/	600
Ferromanganese	3,590	6,780	7,460	8,920 r/	8,500
Ferromolybdenum	2,280	2,670	2,310	2,200 r/	2,300
Ferrosilicomanganese	985	1,670	1,560	1,610 r/	1,600
Ferrosilicon	4,660	5,520	3,380	7,550 r/	5,600
Total	13,400	19,200	16,800 r/	21,000	18,600
Steel, crude 8/	772	807 r/	1,010	1,060	1,040
Semimanufactures	516	587	776	816	775
Lead, mine output, Pb content	1,120	1,050	298	343	1,000 5/
Manganese ore and concentrate:					
Gross weight	39,700	43,800	49,900	63,000	62,900 5/
Mn content	12,500	12,500	12,600 e/	15,900	16,000
Molybdenum:					
Mine output, Mo content	13,600	14,400	14,500 r/	14,900	15,900 5/
Oxides	11,300	10,700	10,400	10,500 e/	11,300
Rhenium, mine output, Re content e/	6,800	6,500	6,600	6,400	6,000
Selenium	49,400	50,600	50,000 e/	49,500 e/	45,000
Silver	655,000	678,000	1,030,000	970,000 r/	983,000
Zinc, mine output, Zn content	25,100	31,000	29,700	29,400	31,000 5/
INDUSTRIAL MINERALS					
Barite	3,040	3,180	2,510	2,040	3,700 5/
Bentonite	1,210	1,050	1,080	989	1,200 5/
Borates, crude, natural (ulexite)	132,000	97,100	203,000	117,000	86,000 5/
Cement, hydraulic	2,120	2,250	2,650	2,600 e/	2,600
Calcite (chalk)	3,780	4,000	4,890	5,660	5,600
Clays					
Cimita	2,970	2,600 r/	405	500 r/	1,000
Kaolin	32,400	63,100	59,100	66,900	73,000 5/
Other (unspecified)	18,600	16,000	20,300	17,000	37,600 5/
Diatomite	3,880	5,560	5,900	5,770	10,100 5/
Feldspar	2,980	4,010	5,740	4,150	10,000 5/
Gypsum:					
Crude	254	336	424	511	552 5/
Calcined e/	106	100 e/	100	100 e/	201 5/
Iodine, elemental	3,980	5,450	5,840	5,550 e/	5,600
Lapis lazuli	192	450	138	250	220 5/
Lime, hydraulic e/	1,300	1,200	1,300	1,300	1,250
Lithium carbonate	9,080	8,580	10,800	10,400	10,400
Nitrogen: Natural crude nitrates:					
Sodium (NaNO ₃)	497	473	515	532 e/	500
Potassium (KNO ₃)	292	317	331	342 e/	300
Total	789	790	846	874 e/	800
Phosphates:					
Guano	1,450	1,310	139	100 r/	2,500 5/
Rock (apatite)	14,000	13,300	17,500	14,600	15,000
Total	15,500	14,600 r/	17,600 r/	14,600 r/	17,500 5/
Pigments, mineral, natural: Iron oxide	15,600	6,760	22,900	7,110	3,300 5/
Potash, K ₂ O equivalent e/	50,000	55,000	55,000	55,000 5/	50,000
Potassium chloride (KCL)	45,100	58,000	58,800	60,000 e/	55,000
Pumice (includes pozzolan)	305	321	385	448	450
Quartz, common	542	486	484 r/	459 r/	590 5/
Salt, all types	1,840	1,680	1,670	1,440	1,700 5/
Sodium compounds, n.e.s.: Sulfate 9/	39,400 r/	33,800	46,400	46,400	46,400
Sand and gravel (silica) e/	300	300	300	300	300

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity 3/	1990	1991	1992	1993	1994 e/
INDUSTRIAL MINERALS--Continued					
Stone:					
Limestone (calcium carbonate) thousand tons	3,780	3,400 r/	4,890 r/	5,650 r/	6,300 5/
Marble	1,350	1,170	894	872	890
Sulfur:					
Native, other than Frasch:					
Refined	28,600	18,900	24,000	937 r/	1,000
Caliche	347	400	450 e/	450 e/	450
Byproduct, (from smelters and oil refining)	187,000	278,000	306,000	385,000	350,000
Total	216,000	297,000	330,000	386,000	351,000
Talc	898	536	1,490	5,060	5,400 5/
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous and lignite thousand tons	2,730	2,740	2,110 r/	1,790 r/	1,700 5/
Coke: Coke oven do.	350	400	300 e/	350 e/	350
Gas natural:					
Gross million cubic meters	4,200	4,070	4,040	4,200 r/	4,150
Marketed do.	2,120	2,300	2,000	2,000 e/	2,000
Natural gas liquids:					
Natural gasoline thousand 42-gallon barrels	695	746	690 e/	680 e/	650
Liquefied petroleum gas do.	2,150	2,090	2,000 e/	1,970 e/	2,000
Total do.	2,850	2,840	2,690 e/	2,650 e/	2,650
Petroleum:					
Crude do.	7,160	6,500	5,420	5,210 r/	5,100
Refinery products:					
Liquefied petroleum do.	2,770	2,500	7,740	7,930	8,000
Gasoline:					
Aviation do.	126	109	53	53	50
Motor do.	12,300	12,500	13,300	13,600	13,400
Jet fuel	1,770	2,290	2,380	2,440	2,400
Kerosene	1,370	1,650	2,190	2,250	2,300
Distillate fuel oil	14,400	15,200	17,900	18,400	18,500
Residual fuel oil	9,300 r/	8,490	1,770	1,810	1,800
Unspecified	1,970	3,470	2,080	2,120	2,100
Total	44,000	46,100	47,400	48,600	48,500

e/ Estimated. r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Table includes data available through Sept. 1995.

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

4/ Figures are the nonduplicate copper content of ore, concentrates, cement, copper, slags and minerals, copper as a byproduct measured at the last stage of processing as reported by Comision Chilena del Cobre (COCHILCO). Mine production reported by Servicio Nacional de Geologie y Minería (SERNAGEOMIN) was as follows, in thousand metric-tons: 1990-1,620; 1991-1,840; and 1992-94, not available.

5/ Reported figure.

6/ Figures are total blister subsequently refined in Feb. 1995. Detailed statistics on electrowinning are now available and reported by the International Copper Study Group, Copper Bulletin (ICSG)-Feb. 1995 as follows, in metric tons: 1990-134.3 revised; 1991-144.1 revised; 1992-122.3 revised; 1993-134.6 revised, 1994-134.4.

7/ 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.

8/ Excludes castings.

9/ Includes natural sodium sulfate and anhydrous sodium sulfate, coproducts of the nitrate industry.

TABLE 2
CHILE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1994

(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 Carbon, S.A. (ENACAR), CORFO's subsidiary (40% Government, 60% private)	VIII, X and XI Regions	1,300.
Do.		Carbonifera Schwagner, S.A. (61%; Agencias Universales, S.A., 39%; 1,500 private shareholders)	X and XII Regions	170.
Do. (sub-bituminous coal)		Cia. de Carbones de Chile, S.A. (COCAR) (Cia. de Petroleos de Chile, S.A., 81%; International Finance Corp. (I.F.C.) (U.S.), 10% and Northern Strip Mining Ltd. (U.S.), 9%)	XII Region, Isla Riesco	1,300.
Copper		Corporacion Nacional del Cobre de Chile (CODELCO-Chile) (100% Government owned)	Mines: Chuquicamata El Teniente Andina Salvador Total	606. 309. 136. 83. 1,134.
Do.	Do.	Do.	Smelters: Chuquicamata El Teniente El Salvador Total	460. 360. 140. 940.
Do.	Do.	Do.	Refineries Chuquicamata (sulfides) Chuquicamata (oxide) El Salvador	600. 85. 130.
Do.	Do.	Do.	SX-EW Plants: Chuquicamata (oxide) El Salvador El Teniente	130. 1. 2.
Do.	Do.	Do.	Sulfuric Acid Plants: Chuquicamata (3 plants) El Teniente	830. 30.
Copper, gold, and silver		Empresa Nacional de Minería (ENAMI) (100% Government owned)	Plants: Taltal, Salado, Matta, Vallenor Chancado	270.
Do.	Do.	Do.	Smelters: Las Ventanas Paipote	145. 80.
Do.	Do.	Do.	Refinery: Las Ventanas	200.
Do.	Do.	Do.	SX-EW Plants: Vallenor, Chancado	20.
Do.	Do.	Do.	Sulfuric Acid Plant: Ventanas	225.
Do.		Cia., Minera Disputada de-Las Condes, S.A. (Exxon, U.S. 87%, ENAMI 13%)	Mines: Mina Las Bronces Mina El Soldado Mina El Cobre	70. 60. 18.
Do.	Do.	Do.	Smelter: Chagres	75.
Do.	Do.	Do.	Sulfuric Acid Plant: Chagres	100.
Do.	Do.	Do.	SX-EW Plant: Tortolas	3.
Copper		Empresa Minera de Mantos Blancos S.A. (private 100%; Anglo-American Corp., 88%; IFC, 12%)	Plant: Mantos Blancos	90.
Do.	Do.	Do.	Smelter: Antofagasta	30.
Do.	Do.	Do.	SX-EW Plant: Mantos Blancos	20.
Do.	Do.	Do.	Sulfuric Acid Plant: Mantos Blancos (shutdown)	200.
Do.		Empresa Minera Escondida Ltda. (BHP, 57.5%; RTZ Corp. PLC, 30%; JECO, 10%; IFC, 25%)	Escondida, Km 135 caminoa Socoma, Antofagasta	390 Cu. 2,200 (Kg. Au).
Gold	kilograms	Cia. Minera San Jose, Ltda. (El Indio Mine, owned by LAC Minerals of Canada, 83%)	Barrio Industrial, Sitio No. 58, Alto Panuelas, Coquimbo	6,300 Au.
Do.	do.	CODELCO-Chile (byproduct from copper) (Government, 100%)	Chuquicamata El Teniente, El Salvador and Andina	2,200.
Gold and Silver	do.	Cia. Minera El Bronce-de Petorca (Private 100%)	Carmencita 240, Las Condes Santiago, Chile	52,700 Au.
Iodine	metric tons	Sociedad Quimica y Minera de Chile, SOQUIMICH, Subsidiary of CORFO (Government, 35%; private, 65%)	Miraflores No. 222, Santiago	5,500.
Potassium nitrate		Do.	Planta Maria Elena, Maria Elena, Prov.	250.

TABLE 2
CHILE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1994

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Sodium nitrate	Do.	Planta Pedro de Valdivia, Pedro de Valdivia Prov.	600.
Sodium sulfate	Do.	Oficina Antofagasta, Anibal Pinto 3228	70,000.
Iron ore	Cia Minera del Pacifico, S.A., CAP's subsidiary (100% private)	Pedro Pablo Munoz 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 Urbinas No 53, Providencia, Santiago	1.0 lead. 31.0 zinc.
Lithium carbonate	Soc. Chilena de Lito Ltda. (subsidiary of Cyprus Foot Minerals Co. of the United States) (100% private)	Huerfanos 669, Santiago	8.6.
Molybdenum	CODELCO-Chile (byproduct from copper) (Government, 100%)	Huerfanos 1,270, Santiago	14.4.
Natural gas	million cubic feet	ENAP subsidiary of CORFO (Government, 100%)	4.
Petroleum	million barrels	Do.	6.5.
Silver	kilograms.	CODELCO-Chile (byproduct from copper)	Huerfanos 1270, Santiago
Do.	do.	Cia Minera San Jose, Ltda. El Indio Mine, (LAC Minerals of Canada, 83%)	235,000. 48,000.
Steel		Cia. Siderurgica de Huachipato S.A., CAP subsidiary (100%, private)	Huerfanos 669, Santiago
			800.