

# CHILE

*By Dr Peter F. Knights*

Chile is a long thin country on the west coast of the continent of South America neighbouring Argentina, Bolivia and Peru. The borders of Chile are defined by the Andean Cordillera to the east, the Pacific Ocean to the west, the Atacama Desert in the north and Antarctica in the south. The country extends 4,270 km from the Region I of Tarapaca in the north, to the Region XII of Punta Arenas in the south, but measures only 425 km wide at its widest point. Chile also includes a section of Antarctica and the Juan Fernandez and Easter Islands. Chile has a population of 15.2 million people, of which 5.7 million live in the capital, Santiago. The principal economic activities of Chile are mining, forestry, agriculture, fishing and aquaculture; the country is known for its world-class wines, and is second only to Norway in salmon exports. Chile has important reserves of copper, molybdenum, gold, silver, and lithium. Principal amongst these is copper; Chile hosts 38% of the world's known copper reserves and produces 35% of the world's copper supply.

Over the decade of 1990-1999 the Chilean economy grew at an astonishing 8.5% average per year. The mining industry has been pivotal to this growth, accounting for 8.5% of the Gross Domestic Product and 47% of all exports during the 1990s (Consejo Minero 2000). In December, the Chilean Copper Commission (Cochilco) estimated total copper production for the year 2000 at 4.511 Mt and projected that this would increase to 4.551 Mt in 2001. A recently published official statistic places copper production for 2000 higher

than this estimate, at 4.603 Mt (Cochilco, January 2001). Chile's estimated precious metal production for 2000 was 52 t of gold and 1,202 t of silver. These figures are predicted to decrease slightly in 2001 to 51.2 t and 1,106 t respectively due to the effect of mine closures. Investment in mining activities during the 1990s accounted for 34.9% of all foreign investment realised in Chile. Last year investment totalled US\$1.36 billion and this is expected to increase to US\$1.94 billion in 2001 due to a number of expansion projects currently in progress.

## Political Roundup

Elections were held in December 1999, with the result that neither the ruling centre-left coalition, comprising the Democratic Christian and Socialist parties, nor the contending centre-right alliance achieved a 50% majority.

### Principal Statistics of the Chilean Mining Sector

	1999	2000 <sup>e</sup>	2001 <sup>e</sup>
<b>Production of Principal Products ('000t except where stated)</b>			
Copper	4,383	4,511	4,551
Gold (t)	48.1	52.0	51.2
Silver	1.4	1.2	1.1
Nitrates	916	1,000	1,200
Potassium Chloride	611	620	650
Lithium Carbonate	30.2	32.0	34.0
Iodine	9.3	9.5	10.0
<b>Return on Exports (US\$ million)</b>			
Copper	6,164	7,000	7,850
Total	7,022	8,052	8,900
<b>Investment in Mining (US\$ million)</b>			
Private	1,221	884	1,200
State	374	476	740
Total	1,595	1,360	1,940
<b>Nominal Prices</b>			
Copper (LME, US\$/lb)	0.714	0.823	0.89-0.94
Gold (London final US\$/oz)	278.8	280	282
Silver (London US\$/oz)	5.22	5.20	5.30

Source: Chilean Copper Commission.

<sup>e</sup> Figures estimated as at 13 Dec 2000.

In a second election held in January in which only the two principal coalitions contended, the centre left coalition led by the socialist Ricardo Lagos narrowly won over the centre right alliance led by Joaquín Lavín. Transition of power occurred at the beginning of March 2000, and one of the first acts of President Lagos was to reduce the number of cabinet ministers by consolidating various portfolios. A 'tri-ministry' comprising Economics, Energy and Mining was created, headed by Minister José de Gregorio and, for the first time, a woman Sub-secretary for Mining was appointed, Jacqueline Saintard.

With the change of government, Juan Villarzu was appointed executive president of the state-owned Corporation del Cobre de Chile (Codelco), the largest copper-mining company in the world. Mr Villarzu, who was president of Codelco from 1994 to 1996, replaced Marcos Lima, who won distinction for his efforts to promote copper when he was voted man of the year in 1999 by the International Copper Association.

In the first three quarters of 2000, the Chilean economy grew at an average of 5.8% (Banco Central, 2000). Inflation was a modest 4.5%, with relatively high unemployment rates of around 10.6% persisting during the first two quarters of the year as a legacy of the recession caused by low copper prices during 1999. Domestic politics was dominated by the legal processing of former dictator General Pinochet for crimes committed during the period of military government in Chile from 1973 to 1990. The divisions which persist in Chilean society concerning the Pinochet era became evident in October 1998 when the retired General was detained in London for extradition to Spain to face charges concerning the disappearance of Spanish citizens during the military government. General Pinochet returned to Chile in March 2000 after a British House of Lords committee formed to review the extradition case ruled that he was medically unfit to stand trial. The position of the Chilean Government throughout the detention was

that the former dictator should be tried in Chile according to Chilean law. Pinochet faces a number of charges in Chile, chief amongst which is his alleged involvement in the so-called 'Caravan of Death' case being investigated by Judge Juan Guzmán. In this case, a military squad toured various cities by helicopter systematically executing a number of political dissidents following the military coup in 1973.

In August, the Supreme Court found that there was sufficient evidence for Pinochet to face charges for his role in the caravan of death, and revoked his right to immunity from prosecution to which his status as life-long senator of the Republic entitled him. In January 2001, Judge Guzmán ruled Pinochet to be the intellectual author behind the caravan of death executions and the retired general was placed under house arrest. In March, an appeal court commuted Pinochet's judgement to that of an accessory to the fact. This does not absolve Pinochet from guilt, but lessens the severity of penalties that may be imposed. As of the second week of March this year, General Pinochet was granted bail, with a revised sentence yet to be announced.

In January this year, a case was brought against General Hernán Gabrielli, second in command of the Chilean airforce, for his alleged involvement in the torture of political detainees at the Cerro Moreno airforce base in Antofagasta in 1973. The processing of senior military officials has strained government relations with the military. However, President Lagos has repeatedly stressed support for the independent judicial system in Chile and has re-iterated that the investigations are not politically motivated.

To foster reconciliation, in May 2000 President Lagos convened a Table of Dialogue comprising key government, military, and church representatives. Under the guarantee of confidentiality and freedom from prosecution, information was solicited concerning detainees missing since the military government period. The results,

made public in November, were generally regarded as a positive step forward, with the fate of some 160 detainees identified.

In August, the government found itself embroiled in a scandal involving indemnities paid to executives retiring from public companies. Although perfectly legal, the size of the indemnities invoked a public outcry when they became public knowledge. President Lagos, classified the behaviour of people who received indemnities as being "against the spirit of public duty" and called for executives who had accepted indemnities yet remained in public employment to either forego their right to indemnities or resign from public office.

In December, the Mining Integration Treaty between Chile and neighbouring Argentina was ratified by the presidents of both countries in a ceremony held in San Pedro de Atacama. The treaty establishes a framework for developing exploration and mining projects in the frontier zone between both countries. More specifically it eliminates the restrictions and prohibitions concerning property acquisition, duty of ownership, and mining rights for reason of nationality of a company, Chilean or Argentinian. The treaty establishes designated protocol zones for frontier projects in which unrestricted movement of personnel between each country is enabled, as well as access to each country's labour and water resources. A first such protocol zone has been established for Barrick Gold's Pascua-Lama property located some 50 km north of its existing El Indio operation. The treaty makes no modifications to those laws that are currently in force in each country.

During August, a project was submitted to Congress to modify various laws aimed at reducing tax evasion. In Chile, companies registered as anonymous societies are subject to a primary category tax of 15%, and repatriated profits or dividends are subject to additional or complementary taxes which total 42% (fixed rate) or 35% (general rate) after

allowing for the 15% primary tax already paid. Amongst the modifications that most concern the mining industry are: the elimination of the right to use accelerated depreciation in calculating complementary taxes; increasing the tax on interest paid on foreign loans from 4% to 35% (this is aimed at limiting the use of relational debt as a tax evasion instrument); and restricting the amount of interest which can be deducted from pre-tax costs to that equivalent to servicing a debt equal to no more than three times a company's equity. Industry bodies such as the National Mining Society (Sonami) and the Mining Council (Consejo Minero), representing the 16 largest mining companies in Chile, have protested loudly against these proposed modifications. The bill will be put to the House of Representatives in April 2001. If approved, progress through the Senate is likely to be slow (proposed legislation to modify the country's water code in order to discourage speculative buying and selling of water rights was approved by the House of Representatives in 1997 and has yet to be ratified by the Senate).

Proposals for new environmental legislation continue to be studied in close consultation with the mining industry. The Chilean Copper Commission (Cochilco) is involved in drafting proposed legislation to govern mine closures, and is currently in the phase of seeking the opinion of interested parties. In March 2001, the Ministry of Economics, Mines and Energy was expected to announce a project to establish norms for acid mine drainage.

### **Mergers and Acquisitions**

Several mergers and acquisitions occurred outside Chile which nonetheless affected the ownership of a number of Chilean copper projects. In December 1999, Phelps Dodge acquired Cyprus Amax, after narrowly missing out on its bid for Asarco. With this acquisition, Phelps Dodge assumed 49% ownership of El Abra SX/EW operation, located near Calama in Region II. Phelps Dodge's other major mining asset in Chile is the Candelaria mine located in Region III

near the city of Copiapó, in which it has 80% participation with the remaining interest belonging to Sumitomo Corp.

Noranda and Codelco Chile joined forces in August 2000, to launch a US\$1.5 billion bid for Rio Algom. At stake were Rio Algom's participation in the Antamina copper-gold-zinc project in Peru (33.75%), the Cerro Colorado mine and undeveloped Spence deposit in Chile (each 100%), the Bajo de la Alumbrera mine in Argentina (25%), and a 33.6% equity in British Columbia's Highland valley copper mine. London-based Billiton countered the Codelco-Noranda bid, and ultimately won control of Rio Algom by paying US\$1.19 billion in cash.

Billiton was once again in the news during March 2001 this time as the result of the announcement of a proposed merger with the Australian group BHP. The new conglomerate, BHP-Billiton, will have a market capitalisation of US\$28 billion and will be owned 58% by BHP and 42% by Billiton. The president of the new conglomerate will be BHP's Paul Anderson, with Billiton's Brian Gilbertson designated as principal corporate advisor. The merger proposal will be put to the share holders of both companies during April 2001. If successful, the new conglomerate will be the second largest mining company in the world, and will have interests in aluminium, coal, copper, iron ore, nickel, diamonds, petroleum, natural gas and steel production. In Chile, the conglomerate will control the Escondida (57.5%), Cerro Colorado (100%) and Spence (100%) projects.

### Exploration

Exploration drilling continued at Barrick Gold's Pascua-Lama property in the III Region of Chile. As of June 2000, reserves stood at 17.1 Moz of gold and 560 Moz of silver. The project, located in mountainous terrain straddling the Chilean-Argentinian border, is governed by a protocol signed by both countries permitting its development. Barrick is contemplating developing the

project in three phases; in the first phase, lasting three years, the mine will have a capacity of 33,000 t/d and will produce some 800,000 oz/y of gold. In the second phase, capacity will be increased to 44,000 t/d and the mine will produce 1 Moz/y of gold. The third phase contemplates moving the mill currently installed at the existing Tambo mine some 50 km distant to boost capacity by a further 6,000 t/d and thus maintain the output at 1 Moz/y in the face of declining grades. The project requires an investment of US\$950 million, and is forecast to produce gold at between US\$60 and US\$65/oz. Although the majority of the reserves are located on the Chilean side of the border, the latest engineering plans call for the mill and tailing dam to be located in Argentina due to topographic considerations. Environmental Impact Studies have been submitted to both the Chilean and Argentinian Authorities. However, in January 2001, in a move that surprised industry observers, the company announced the indefinite suspension of the project due to low gold and silver prices.

In March 2001, Placer Dome submitted an Environmental Impact Study (EIS) to regional authorities for the Cerro Casale copper-gold-silver project. The deposit is located in the Aldebarán prospect 145 km southeast of Copiapó in the III Region of Chile. The deposit contains 23 Moz of gold at an average grade of 2.7 g/t and 27 Mt of copper grading 0.26% Cu. The controlling partners are Placer Dome (51%), Bema Gold (24%) and Arizona Star (25%). The EIS contemplates a mine to produce 17 Moz of gold, 32 Moz of silver and 2 Mt of copper over an 18-year life. The mine requires an estimated investment of US\$1,430 million.

In 2000, Codelco allocated a US\$7 million budget to continue delineating the Gaby Sur porphyry copper deposit located in Region II, 105 km south of Calama. The deposit, discovered in March 1996, contains a resource of 400 Mt grading 0.54% Cu. The deposit, drilled on a grid of 100 by 100 m, extends 2.2 km north-south by 1.1 km wide.



An oxide cap extending some 130 m deep exists under approximately 50 m of overburden. In December Codelco announced that it would invest in a further 28,000 m of drilling on the project, adding to the 55,000 m drilled to date. The results of this exploration campaign should be known by May or June of 2001. A decision regarding the optimum mine capacity will be taken when the reserves are better defined. A project to produce 120,000 t/y of cathode copper is estimated to require an investment of US\$400-450 million.

Codelco plans to spend US\$20 million during 2001 quantifying reserves at the Mansa Mina project in the north. The money will primarily be spent on drilling and bulk sampling to convert resources into reserves. Mansa Mina, located 7 km to the south of Chuquicamata Division's Mina Sur mine, is a porphyry deposit with average grades around 1% Cu. The deposit includes a system of breccias having grades as high as 4% Cu, but these are associated with high concentrations of arsenic and silver. Because of the high arsenic content, Codelco is reported to be evaluating the feasibility of bioleaching the ore using the patented BioCOP® process developed by Codelco and Billiton.

Codelco was also active in a number of exploration joint ventures. In June, it signed exploration agreements with North of Australia and Lowell Minerals of the US. The agreement with North covers the Tuina prospect in Region II, whilst that with Lowell covers exploration in the Mamina prospect in Iquique province. Codelco was actively exploring in Mexico, through a joint venture with Industrias Peñoles, and was expected to sign an agreement with Grupo Mexico to conduct exploration in Peru, where Grupo Mexico holds 54% of Southern Peru Copper.

In March, the Prospectors and Developers Association of Canada awarded the Prospector of the Year award to the team of Rio Algom geologists who discovered the Spence deposit, located 140 km northeast of

Antofagasta. The deposit contains reserves of 398 Mt at an average grade of 1.0% Cu. Rio Algom was contemplating investing US\$1 billion to develop a mine in two phases. The first phase contemplated producing 41,000 t/y of cathode copper, followed by the construction of a mill to process a further 60,000 t/d giving a total output of 190,000 t/y of fine copper. With the acquisition of Rio Algom by Billiton, the new owners are reported to be also evaluating the applicability of bioleaching Spence's sulphide ore using the BioCOP® process.

### Development

Construction of Chile's newest mine, El Tesoro SX/EW copper project owned 61% by the Luksic Group and 39% by Equatorial Mining (a subsidiary of the Australian financial institute AMP) began in November 1999, with mechanical completion scheduled for April 2001. The mine is located near the main highway connecting Antofagasta with Calama in Region II, and contains reserves of 175 Mt grading 0.94% Cu. When completed, the mine will produce 75,000 t/y of cathode copper, at an expected cash cost of US\$0.392/lb during the first year of operation and an average US\$0.41/lb during the first five years of operation. Total investment in the mine is some US\$296.3 million. The construction of El Tesoro was 89% complete at the end of 2000 and remained on schedule and within budget. The first cathode production is expected in May this year.

In a further sign of growth in mining investment from the private sector in Chile, development has commenced on the Atacama Kozan underground copper mine located near Tierra Amarilla in Region III. The Chilean company Inverraz, directed by well known businessman and politician Javier Errázuriz, has a 40% participation in the project, with the majority 60% controlled by Japanese company Nittetsu Mining, part of the Nippon Steel group. The project requires an investment of US\$110 million. Initial production will be in the range of 28,000 to 30,000 t/y of fine copper in the form of copper

concentrate. Mineable reserves are estimated at 20 Mt averaging 1.5% Cu and 0.3-0.4 g/t Au, and the probable mine life will be 11 years. Cash operating costs will be in the order of US\$0.60/lb and production is scheduled to start in the December quarter of 2002. Construction of the mill is scheduled to begin in the June quarter of 2001.

In September, Codelco announced an ambitious plan to double the net worth of the company to US\$18 billion by 2006. The plan calls for investing US\$3.6 billion over six years (US\$750 million in 2001 alone), and generating profits of US\$1.4 billion annually for the first three years, followed by US\$1.5 billion per year thereafter. Integral to the plan is a project to effect legal changes to enable the state-run company to compete on the same footing as private mining companies. This consists of modifying the present composition of the board of directors, revising the taxation structure to which the company is presently subjected and modifying law 19.137 governing the company's purchase and sale of assets. Codelco is also studying the possibility of restructuring itself according to business processes as opposed to the geographical division of the company that has existed since the 1980s. One possibility being explored is the creation of a Codelco North division, comprising the existing Chuquicamata and Radomiro Tomic Divisions.

Codelco's star performer remained Radomiro Tomic. As a result of better than expected grades and improved recoveries in the heap-leaching process, in 1999 the division produced 190,104 t of copper cathodes, 5.6% in excess of its design capacity of 180,000 t. Cash costs were below US\$0.34/lb CIF with total costs of around US\$0.44/lb. A US\$212 million expansion was carried out during 2000 to increase the capacity of the division by 76,000 t/y to 256,000 t/y of copper cathodes. The expansion involved the acquisition of a new mining fleet, including a 56 m<sup>3</sup> cable shovel and eight 300 t capacity trucks; widening of the dynamic heap-leach pad; and

expanding the SX/EW facilities. The division is currently studying the feasibility of secondary leaching of leached waste in order to recover remaining copper.

Chuquicamata Division continued its modernisation programme in 2000 by embarking on a major asset replacement programme for the mine. The division purchased two 56 m<sup>3</sup> cable shovels and a fleet of 17, 300 t capacity trucks. During 2001 the division will initiate two projects; one to optimise integral mine and mill performance, and a second to move 2,500 families from the Chuquicamata mining camp to the town of Calama in order to free space for future waste dumps. Codelco has also announced that it will begin to study the feasibility of developing an underground panel caving operation at Chuquicamata to access the sizeable reserves remaining at depth.

In August, Codelco's board of directors approved an expansion of El Teniente Division to raise annual production from the current 350,000 t of copper to 480,000 t beginning in 2003. El Teniente is the world's largest underground copper mine, employing panel-caving mining methods. To date, US\$422 million in investment has been approved, of which US\$340 million will be used to lift concentrator capacity. According to El Teniente's general manager, Ruben Alvarado, a further US\$130 million will be spent at a later date to increase the division's smelting capacity.

In March 2001, Codelco presented environmental impact studies (EIS) to regional authorities for two projects at the Andina Division; one to expand the capacity of the mine to 135,000 t/d and the second to construct a treatment plant for mine waste water. The projects will require an investment of approximately US\$600 million during 2001-2006. Most of the increased production will come from expanding the open-pit operations at Andina. The Sur-Sur La Union, and Don Luis open pits will be expanded to 80,000 t/d of production, with the underground panel-

caving operation continuing to produce at its current level of 45,000 t/d. During 2001 the division will make refinements aimed at boosting capacity by 4,000 t/d to 74,000 t/d.

Codelco will also invest US\$300 million in projects at El Salvador Division during 2001-2006 with the objective of almost doubling the net present value of the division from US\$400 million to US\$900 million. The investments will principally be targeted at hydrometallurgical projects and smelter and refinery expansions. A new open-pit operation, Damiana, will be initiated in order to maintain SX/EW cathode production at 25,000 t/y. Smelter capacity will be expanded from 520,000 t/y to 680,000 t/y of dry concentrate in 2003. Refinery capacity will be increased from 137,000 t/y to 200,000 t/y. A pre-feasibility study is currently being conducting for the refinery expansion which, if approved, is expected to be operational in 2004.

El Abra mine, in which Phelps Dodge holds the controlling 51% interest and Codelco the remaining minority interest, will shortly commence a US\$77 million expansion to leach low-grade, run-of-mine (ROM) ore. In March 2001, the EIS for the ROM project was approved by regional environmental authorities. Due to problems which persist in separating sulphide and oxide ores, El Abra produced 217,400 t of cathode copper in 2000, slightly less than its design capacity of 225,000 t.

In November, the joint venture partners in the Escondida copper mine (BHP 57.5%, Rio Tinto 30%, Japan Escondida Corp. 10% and International Finance Corp. 2.5%) approved a US\$1.045 billion phase 4 expansion that will increase the plant capacity by 85% and increase average copper production by 400,000 t to 1.2 Mt/y over the first five years of full operation. The approval was delayed by negotiations with neighbouring Zaldivar mine to seek a stable water supply. Detailed engineering work has been completed to 97% and construction will begin immediately, with

first production from the new concentrator expected in September 2002. Escondida is already the world's largest copper mine, and in the 12 months to June 30, 2000, output was 920,000 t, representing over 9% of the world copper market.

Further ahead, the joint venture partners are considering the development of Escondida Norte, located 5 km north of the existing open pit. Indicated resources amount to 676 Mt of sulphides averaging 1.03% Cu plus 12 Mt of oxides averaging 0.76% Cu. Inferred resources amount to 796 Mt of sulphides averaging 0.76% Cu and 131 Mt of oxides at 0.73% Cu. The development concept for Escondida Norte involves mining, crushing and conveying the highest grade ore to one of Escondida's concentrators, and bioleaching of the lower grade material. In addition, BHP says that the phase 4 expansion of Escondida, coupled with the Norte project, enhances the potential of bioleaching of sulphide ore. Pilot leaching has begun, and commercial demonstration heaps are planned shortly with a view to producing 100,000 to 150,000 t/y of low-cost copper cathode.

In May 2000, Cía Minera Disputada Las Condes, owned by Exxon, announced two projects to expand the Los Bronces open-pit copper mine located in the Andean Cordillera in the Metropolitan Region of Santiago. The projects include the expansion of the mine and concentrate plant from 37,000 t/d to 54,000 t/d and the construction of a second SX/EW plant to leach low-grade waste material. The projects require a total investment of US\$200 million and are expected to be operational by the beginning of 2003. When complete the expansion will lift concentrate production by 60,000 t/y and cathode production by 20,000 t/y.

In November, Kvaerner Metals was awarded a contract to conduct a feasibility study to increase the capacity of the Collahuasi copper mine from 60,000 t/d to 110,000 t/d. Collahuasi is owned by Falconbridge (44%),

Anglo American (44%) and a Japanese consortium lead by Mitsui. The study is due to be completed by the end of 2001. Construction is also likely to begin this year to develop the Fortuna de Cobre deposit, located 3 km from the Lomas Bayas mine, owned by Boliden. The Chilean newspaper *El Diario* reports that the deposit contains an estimated 848 Mt at 0.24% Cu. Fortuna de Cobre has a favourable stripping ratio of 0.5:1 waste to ore, and is expected to produce about 90,000 t/y of cathode copper, requiring an investment of US\$300 million. In March 2001 the Canadian companies Noranda and Falconbridge signed a letter of intent to purchase Lomas Bayas and Fortuna de Cobre from Boliden for the sum of US\$175 million, plus cash balances of US\$2.1 million less third-party debt obligations of US\$112.7 million. An additional US\$15 million is payable if the purchasers exercise their right to retain Fortuna de Cobre before the fifth anniversary of closing the agreement. The deal is subject to regulatory approval and approval of the boards of directors of both companies.

Noranda's Altonorte smelter located near Antofagasta is currently undergoing a US\$170 million expansion to elevate production from 400,000 t/y to 820,000 t/y. The project involves converting the smelter to natural gas; the replacement of the reverberatory furnace with a continuous reactor; replacement of three Pierce Smith converters with larger capacity units; installation of a third refining furnace; and the likely installation of a second anode wheel. The converter, which measures some 5.3 m in diameter and 26.4 m in length, is based on a combination of technologies developed by Noranda and Codelco (a technology-sharing agreement exists between the two companies). The first phase of the expansion is due for completion in November 2001. A second phase of the expansion contemplates the construction of a new acid plant to lift sulphur dioxide capture from 85% to 93%. Noranda was also reported to be dusting off plans to develop the US\$2.6 billion Alumysa aluminium refinery near Puerto Aisén in

Region XI. The project has been the subject of intense environmental debate owing to its potential impact on tourism in the region.

Financially troubled state-run minerals processing company Enami announced the placement of a bond offer in March this year for US\$150 million in an attempt to substitute short-term debt for long. Enami operates two copper smelters, Hernán Videla Lira located at Paipote in Region III and Ventanas located on the coast in Region V. Modernisation work continued at Hernán Videla Lira, with a US\$18.7 million electric furnace installed as part of an investment plan approved during the administration of the previous Frei government. In May, President Ricardo Lagos announced that a feasibility study would be commissioned to construct a copper refinery at Paipote. At present, copper anodes produced at Hernán Videla Lira are trucked to Ventanas for refining. In March 2001, Codelco was reported to be involved in talks to form a partnership with Enami in order to expand the capacity of the Ventanas smelter and refinery. The smelter currently has a capacity of 450,000 t/y of concentrate and the refinery capacity is 320,000 t/y. The expansion could possibly boost capacity to 820,000 t/y in 2006.

In February 2001, the Chilean company Atacama Minerals commenced construction of the Aguas Blancas iodine plant in the north. The plant requires an investment of US\$27 million, and, when completed, will produce 7,200 t/y of iodine. Speciality fertiliser producer SQM is currently investing US\$70 million in the construction of four new fertiliser plants. Cement producer Cemento Polpaico received necessary environmental approvals to construct a 300,000 t/y cement plant at the port complex of Mejillones, north of Antofagasta. The plant, which requires an investment of US\$20 million, is due to begin operation in the second half of 2001. Environmental approval is still pending for the development of two small mines located near Antofagasta intended to supply gypsum and pozzolan to the plant. Cemento Melón, a



subsidiary of Blue Circle, will invest US\$18.8 million during 2001 in the optimisation and modernisation of the Navio mine and plant located near La Calera in Region V.

## Production

Chilean copper production was up 4.3% in 2000 compared with 1999. However, with the average LME copper price being US\$0.82/lb during 2000 compared with US\$0.71/lb during 1999, the value of copper exports for the period January-November of each year was up from US\$5,509 million to US\$6,703 million, an increase of 21.7%. Molybdenum concentrate production also increased from 17,610 t to 23,463 t in 2000, an increase of 33.2%. Molybdenum trioxide production improved marginally from 9,699 t to 9,724 t, an increase of 0.3%.

The increased copper and molybdenum concentrate production are principally due to the first full year of operation of Antofagasta Mineral's Los Pelambres mine, located in Region IV. In its first full year of operation, the mine produced 310,200 t of fine copper, 8.6% in excess of its design capacity of 285,600 t. This increase is attributed to refinements in the concentrating plant, in particular changes in the configuration of the liner and lifters employed in the SAG mills. Los Pelambres is currently in the process of evaluating several expansion alternatives, with no firm commitment expected until the latter part of 2001.

During the period January-November 2000 Codelco's production was 1,418,600 t of fine copper, up 2.1% compared with the same period in 1999. Production at the Andina Division was estimated to be 270,000 t of fine copper in 2000, 8.3% in excess of the 249,328 t produced in 1999.

Cía Minera Disputada Las Condes produced 253,977 t of fine copper in 2000, a company record 2.3% higher than the 248,331 t produced in 1999. Los Bronces mine produced 169,703 t of fine copper in concentrate and 11,745 of copper cathodes.

The average head grade of Los Bronces mine during 2000 was 1.21% Cu, compared with 1.23% in 1999. Disputada's El Soldado mine produced 66,238 t of fine copper in concentrate and 6,291 t of cathode copper.

The Collahuasi mine produced 436,000 t of fine copper during 2000, exceeding the production target of 420,000 t. The majority of this production was copper concentrate, with some 56,000 t of copper cathode.

Minera Escondida produced 916,624 t of copper in 2000, of which 776,386 t were fine copper in concentrate and 140,239 t copper cathode. This was down 4.4% in relation to 1999, due primarily to lower head grades. The average head grade during 2000 was 1.9% Cu, a 7.3% reduction from the 2.05% Cu average of 1999. Minera Escondida's president, Bruce Turner, stated that cash costs of production during 2000 were US\$0.422/lb as compared with US\$0.405/lb in 1999. The phase 4 expansion is expected to reduce cash costs by a further US\$0.035/lb when operational.

Mantos Blancos, which operates the Mantos Blancos mine located near Antofagasta and the Manto Verde mine located inland of Chañaral in the Region III of Chile, produced 155,300 t of fine copper during 2000, a 2.4% increase compared with the 151,600 t produced in 1999. During 2000, Anglo American successfully launched a public offer for the remaining Mantos Blancos shares listed on the Santiago stock exchange, increasing its ownership in the company from 77.4% to 99.97%.

<b>Chilean Copper Production 1999 - 2000 (Mt)</b>			
<b>Product</b>	<b>1999</b>	<b>2000</b>	<b>Variation</b>
Cathodes SX/EW	1.3621	1.3736	0.8%
Other refined	1.3043	1.2960	-0.6%
Blister	0.1696	0.1644	-3.1%
Concentrate	1.5552	1.7693	13.8%
<b>TOTAL</b>	<b>4.3912</b>	<b>4.6033</b>	<b>4.8%</b>

Source: Cochilco, Jan 2001.

Production at the Cerro Colorado mine for the first 11 months of 2000 was 102,700 t, up 10.1% on the same period of 1999. Production at the Quebrada Blanca mine was down 11.2% for the same period, from 67,700 t to 60,100 t, due largely to a four-week industrial dispute which occurred in June concerning a new collective labour agreement. Also in June, Aur Resources agreed to buy the 76.5% participation in Quebrada Blanca belonging to Cominco and Teck.

The Candelaria mine (Phelps Dodge 80%, Sumitomo 20%) produced 211,141 t of fine copper during 2000, down 10.3% compared with the 235,438 t produced in 1999 due principally to declining grades. In March, Candelaria became one of the first copper mines in the world to receive full ISO 14001 certification for its environmental management systems. Independent certification was sought and attained for both the copper mine and port facilities. The standard governs five general areas; policy; planning; implementation; monitoring and measurement; management review and continuous improvement. It is understood that other copper producers, including Minera Escondida and Codelco's Chuquicamata Division, are also implementing plans towards obtaining ISO 14001 certification for their mining operations.

Chile's precious metal producers continued to experience difficult times. The average price of gold during 2000 remained low at US\$279/oz compared with US\$278.8/oz for 1999. In addition, LME silver prices plummeted 5.2% from an average of US\$5.22/oz in 1999 to US\$4.95/oz in 2000. Low metal prices forced the closure of Dayton's Andocollo gold mine in Region IV, although some production continues from residual heap leaching operations. The Fachinal mine in Region XI, owned and operated by Coeur d'Alene Mines, was also closed in the last quarter of 2000. The mine produced 16,077 oz of gold and 900,000 oz of silver in 2000, substantially down from the

25,480 oz of gold produced in 1999. Total production costs for the year were US\$477/oz, compared with US\$304/oz in 1999. In March 2001, Coeur d'Alene announced that it was seeking to sell its assets in Chile. The assets, which include El Bronce mine, located at Petorca 145 km north of Santiago, as well as two undeveloped high grade deposits, Cerro Bayo and Furioso deposits located near Fachinal, have a book value of US\$20.2 million. In February 2001, Barrick Gold announced a proposed 25% reduction in personnel at its El Indio mine located in Region IV. As previously mentioned, Barrick also suspended its decision to proceed with the construction of the Pascua-Lama gold-silver project located 50 km north of El Indio.

The one bright point in the year concerning gold was El Peñon mine, located 240 km south-east of Antofagasta, and owned and operated by Meridian Gold. The mine, officially inaugurated in January 2000 by previous President, Eduardo Frei, has a capacity of 2,000 oz/d and employs conventional open stoping. The mine produced 213,000 oz of gold up to September 2000, at a direct production cost of US\$50/oz and total production cost of US\$95/oz. It was expected that the total production for 2000 would be 285,000 oz. Proven and probable reserves total 2.8 Moz of gold and 46 Moz of silver. During 2000, exploration drilling was carried out on the Cerro Martillo and Quebrada Colorado veins, resulting in mineralisation being encountered in the extreme south of the property at 100 m, open at depth.

### Research and Development

In March Codelco-Chile agreed in principle to form a 50:50 joint venture with Billiton to apply Billiton's patented copper bioleaching technology on a commercial basis. The two companies have been working together on the BioCOP® technology for three years with pilot plants in both Billiton's research facilities in South Africa and the Chuquicamata Division of Codelco. BioCOP® essentially

takes a flotation concentrate from the treatment of primary copper ore and bioleaches the contained copper into a slurry containing soluble copper sulphate. The process takes place in stirred tanks with the main cost input being oxygen in the form of air.

During 2000, Chilean universities were active in a number of research projects relating to the mining industry. In a major study funded by International Copper Association and the Chilean Government, researchers at the Mining and Metallurgical Research Centre (CIMM) and the Catholic University of Chile continued to investigate the toxicity effects of copper in the environment. In the face of increasing stringent environmental restrictions being considered by European countries, the research aims to influence the debate concerning the allowable copper content in potable water and thus ensure the market participation of copper water pipe. Researchers at the University of Santiago were actively developing a prototype automated hydraulic hammer for secondary rock breakage, and the University of Chile began a three-year project to model and understand the phenomena of block caving in

primary rock. Codelco is the participating industrial partner in the latter two projects.

### **Outlook**

At the end of 2000, a number of companies, industry bodies and government entities made public their price predictions for copper for 2001. The most conservative estimate was that of the Mining Council, at US\$0.89/lb. Minera Escondida was the most optimistic, predicting an average price of US\$0.95/lb. Between these estimates were Codelco's forecast of US\$93.0/lb, the Chilean Copper Commission's US\$91.5/lb, the National Mining Society's forecast of US\$0.90-0.95/lb and Antofagasta Minerals (Luksic Group) prediction of US\$0.90/lb. General consensus is that the copper price will be significantly improved on the US\$82.29/lb average observed for 2000, and the industry attitude is bullish for the forthcoming year. In the words of Diego Hernández, President of the Mining Council, the Chilean mining industry "faces a scenario of growth and progress that should continue the positive trajectory experienced by the Chilean mining industry over the past decade."