

Mining in Chile

The engine that moves Chile forward

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Cover photo: View of Anglo American's Los Bronces operation, courtesy of Anglo American.

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Mining activity will be the engine that moves Chile forward in the next decade

Enjoying political stability, the world's largest copper-producer has set an example in the development of its mining sector and related industries.

The economy of Chile is one of South America's most stable and prosperous, with the highest nominal GDP per capita in Latin America. The Global Competitiveness Report by the World Economic Forum for 2011-2012 ranks Chile 31st, topping all Latin American countries, well above Brazil (53rd), Mexico (58th), Peru (67th) and Argentina (85th). The Ease of Doing Business Index of the World Bank for 2012 lists Chile as being the 29th most competitive country in the world and the first in Latin America.

The mining sector is one of the pillars of the Chilean economy. The Chilean government strongly supports foreign investment in the sector and has modified its mining industry laws and regulations to create a favorable investing environment for foreigners. Thanks to large copper resources, progressive legislation and a healthy invest-

ment environment, Chile has become the copper-mining capital of the world, producing over a third of global output.

In recent decades, mining activity has led Chile's economic growth. Mining projects are not seen as isolated enclaves but as active promoters of regional development and generating new sources of employment. Increased investment in exploration and mining stocks, greater output and exports of mineral products and their derivatives have been key factors that have contributed to the development of communities.

In the words of the President of Chile, Sebastián Piñera, at the annual meeting of the Mining Council (Consejo Minero) held in November 2011, "The mining industry represents a little more than 20% of Chile's GDP, equal to more than US\$40 billion and generates direct employment

for approximately 110,000, and indirect more than 500,000 people."

"Mining is Chile's engine," said Hernán de Solminihac, Chilean Minister of Mining, when talking about the overall mining investment portfolio by 2020, which is estimated to equate to US\$66.8 billion. This continual growth is based not just on the industry expanding, but also on it becoming more sophisticated and diverse.

Traditionally, Chile's mining strength has been based on a single commodity: copper. In the past two decades, Chile has consolidated its position as world leader in copper production, raising its global market share from 17.7% in 1990 to 34.2% in 2011. Mine copper output in 2011 reached 5.69 million metric tons (mt) of refined copper, a 267,000 mt or a 5.0% annual increase on the previous year. (cont. on page 52)



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“Our priority is to improve safety”

Interview with Hernán de Solminihac, Minister of Mining, Chile

Which are the main bodies under the umbrella of the Chilean Mining Ministry?

There are various governmental institutions subordinate to the Ministry of Mining. Cochilco is the institute that advises the Chilean government and private players on matters concerning the production of copper, copper byproducts, metals and industrial minerals, with the exception of coal and fuels. Sernageomin provides specialized technical advice on geological and mining matters to the Ministry of Mining. ENAMI (Empresa Nacional de Minería) aims to encourage the development of small and medium mining companies, helping them to access the market of refined metals, under competitive conditions.

There is currently a law under discussion that reconsiders the structure of the Ministry of Mining. The proposition will give a new direction to the aforementioned institutions and hopes to create additional institutions, such as an Institute of Geology, which will be responsible for research, development, organization of data and advice on geological features and another institution, “Superintendencia de Minas”, will be dedicated to monitor and ensure compliance with mine safety regulations. This law is yet to be approved.

You were recently nominated as Minister of Mining. What are the main initiatives that you hope to see approved during your Ministry?

Our priority is to improve mining safety. After the Mina San José accident, the government has been working intensely to lower accident rates. The San José mine accident was, without a doubt, an accident with a positive outcome, and important lessons were learned from it by the whole industry in Chile. Additionally, the ministry has improved the taxation system and increased assistance to small mining businesses, as we are aware that most accidents occur in this specific market sector. Thanks to this effort and the raised awareness of safety concerns, the fatalities rate in the first eight months of 2011 were reduced by more than 50% compared to the same period last year. At the same time, we have proposed a regulation that puts increased emphasis on safety, improving working conditions and safety at altitude.



Another project, which has already been approved by congress and is in its final stage of approval, is a law requiring mining companies to prepare a closure plan for the mines before the start of operations to minimize the environmental impact of mines.

The state mining company Codelco was the subject of legislation last year. What are the main changes that have been made to Codelco's corporate governance?

In March 2010, a new legislation was approved which makes Codelco's corporate governance more independent from the government. The government designates three directors directly, and the rest are nominated by the corporate president, with the proposition of high public direction, an organization that selects the candidates for the positions. Also, two directors are proposed and selected by the workers.

The question of private capital in Codelco has also been a long running discussion in Chile. The President Sebastián Piñera has been clear about the fact that Codelco is, and always should be, a state company. Despite this, there might be specific projects in which Codelco can participate in cooperation with private capital.

What are the initiatives in Chile to counteract the lack of professionals in the mining sector?

We are assessing the profile of the professionals needed, the quantity and the salary that each type of profile would get. When demand is quantified, it is easier to solve the problem. We have worked with universities and technical institutes to adjust cur-

ricula to adapt to the need of the mining sector and, by being aware of the prospective salaries, we are able to show students the prospects that this activity can offer. We have also created programs to train people from other industries, allowing them to transfer into mining. Companies are also directly training people who are interested in entering the sector.

An important subject for our country is the participation of females in the work force; both government and private sector have made a significant effort in this regard. Today there are examples such as Minera Gaby, where the workforce is currently 20% female, and Esperanza, where the workforce is currently 12% female. There has been a definite advance in this line of work.

How can Chile attract more junior companies? Is the regulatory framework too favorable to major companies?

In Chile there are currently 8,000 mining operations, out of which around 20 are held by large companies. The amount of companies is colossal. Considering production levels, big companies are majority, but if you look at the quantity of companies, there are considerably more small and medium mining companies.

The government is working alongside with CORFO (Corporación de Fomento de la Producción), to create the Fénix fund, in which the state has invested US\$92 million, and the private sector delivered around US\$58 million, to support the participation of junior companies in the exploration of new mineral deposits.

How will you ensure Chile's global leadership for copper production in the future?

The mining industry today has about US\$67 billion worth of investment to be put in place in the next eight years, of which around US\$20 billion belong to Codelco, and the rest to private companies, with the objective of increasing the production on current mines, generating new production, making existing mines more efficient, and surpassing 5.4 million mt of fine copper. We expect that the materialization of these projects will maintain Chile's leadership in world copper production.

MINING IN CHILE



Andrés Mac-Lean, executive vice president of the Chilean Copper Commission (Cochilco)

(cont. from page 50) According to Andrés Mac-Lean, executive vice president of the Chilean Copper Commission (Cochilco), "The trend should stand over the short term, with production in 2013 expected to reach a record 6.12 million mt".

Chile has been the leading global producer of copper since the 1990s when the process of liberalization opened the Chilean market to the arrival of large international mining companies, whose investments led to a tripling of the country's copper production so that in 1999 Chile produced roughly 35% of the copper mined in the world.

Since then, the industry, followed by the state owned firm Codelco, has introduced new management practices, new technologies and strong investment in training and skills development.

As a result, the extraction of copper between 1993 and 2005 was equal to the amount of ore mined in the previous 92 years. Increasing productivity and reducing production costs have ensured Chile's mining competitiveness in international markets. In 2002, Chile ranked first in the Fraser Institute's Annual Survey of Mining Companies as the most attractive country in the world for mining investment, both for its geological potential and its political stability.

Moreover, since the beginning of the last decade, prices of copper have increased in response to the sharp rise in demand from emerging Asian countries. The London Metal Exchange LME index of six primary metals including copper and aluminum fell 22% last year, the first drop in three years.

However, copper prices may gain as much as 25% in the second half of this year on steady demand from China, the world's top consumer, and amid tight supplies. According to Yuka Kageyama, a commodity derivate analyst at Mizuho

Corporate Bank Ltd (MIZC), prices will climb to as high as US\$9,500/mt from last year's close of US\$7,600/mt.

Despite this traditional and continued focus on copper, which accounts for more than 60% of the total mining Chilean exports, other minerals are also receiving increased attention. In 2011, Chile ranked first globally in copper, lithium and rhenium, third in molybdenum, fifth in silver and 15th in gold. Chile was also one of the world's significant producers and exporters of potassium nitrate and sodium nitrate and ranked second after Japan in world production of iodine.

Over the next four years, there will be a substantial increase in silver, copper and, especially, gold output. Moreover, Chile is one of the most significant producers of arsenic, boron, refined selenium, pumicite, sulfur, salt and diatomite.

However, the Chilean mining industry needs to face certain challenges including access to water, energy and the lack of qualified personnel. Nevertheless, the stable political and economic situation and the mining regulation framework support confidence and foresight for investments in the country; the production potential of Chile is huge and long-term projections are positive.

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Maintaining Global Leadership

Interview with Diego Hernández, President and CEO of Codelco

What is your vision for Codelco governance?

Codelco is the number one copper producer worldwide, which is a position that we have held for the last 40 years. We are in a period where we need to invest much more than what we have invested before; from 2011 we had to invest the same amount of money that we have invested over the last 35 years.

In 2014 we will run out of oxide ore at Chuquibambilla where we have a plant that produces 150,000 mt/y; we are mitigating that risk by developing the Quetena and Alejandro Hales projects. We will lose access to the ore we are mining now in Chuquibambilla unless we transition from open-pit mining to underground mining. The location of the ore at El Teniente is 300m deeper compared to the current level of the ore. The new underground level of El Teniente will cost additional investment.

Moreover, to increase our production, Codelco will require the construction of an additional plant to process sulphides, which should be completed by 2017. We are providing Ministro Hales, which produces 150,000 mt/y, with an open-pit concentrator. We also have projects in Salvador, which at present produce 70,000 mt/y, but we can increase this by constructing an open pit on top of underground workings and smaller open pits. This would give us access to the source of 1 billion mt of ore at grades of 0.5% and we are currently collecting the geological information for the project.

We are performing a feasibility study at the San Antonio project to produce 60,000 mt/y, which will provide future access to 800 million mt of sulphide reserves that are below the oxides. The production at Salvador should increase from 70,000 mt/y to 200,000 mt/y.

Andina is a project in the feasibility stage and we plan to build a concentrator to increase production from 250,000 mt/y to 600,000 mt/y. If we execute all of the projects, copper production will increase from 1.75 million mt/y to 2.1 million mt/y, but if we do not execute any projects then our production will drop to 800,000 mt/y by 2020.

Codelco intends to improve its position in the industry in terms of cost. We want to decrease costs by 25% by the second half



of 2012 and the investments will help us to become more competitive. The projects will allow us to have bigger plants with less people and will improve our productivity.

How do you plan to improve efficiency?

Codelco will use the same tools that private companies use. Codelco is a state company that had to comply with new rules introduced by new governors when Chile joined the Organization for Economic Co-operation and Development (OECD) in 2010. The Minister of Finance and Minister of Mining represent the shareholders. This system gives more flexibility to the company and enables us to achieve better business results.

Moreover, Codelco needs to take advantage of all of our investment programs to update our current technology and include the latest generation of equipment in a way that we can be more competitive. We run our own programs in some fields through different approaches in partnerships with some service companies, universities and research and development entities. In some fields we have internal research and development in underground mining for blockading, automation, working at distance, the pre-conditioning of rock, continuous mining and bio-leaching, although when we can find available technology in the market we do not try and develop it ourselves.

What is the mission of the mining cluster in Chile that Codelco has been organizing?

The project is aimed at helping service companies that are in the mining cluster to

expand and become global companies that can be competitive abroad. We have influence to contract their services and there are many service companies who can provide us with solutions using innovation and technology to solve our challenges.

We have selected companies that are in the program and our target is to help them improve their quality and potential by offering them contracts. We encourage companies to incorporate new innovations and the common target is to increase the number of companies in the cluster program to 250 by 2020.

What is Codelco's strategy regarding power supply?

We have secured power contracts with power companies, which is important as we believe that in the future there will be a shortage of power. Therefore we need to pressure power companies to increase their capacity because there is enough interest in the market.

The cost of power has increased following the growth in the demand. This has affected our competitiveness so we are looking for alternatives to decrease the cost.

How do you face the shortage of skilled professionals working for the industry?

We need to prepare the company for the next generation of employees as Codelco has a higher than average age of staff in the industry. We have started to employ people through apprenticeships and through graduate programs and we are focused on human resources.

All of these initiatives will work in conjunction with health and safety programs, environmental and community initiatives and we are making a special effort to improve our working practices.

What is your final message to Engineering & Mining Journal's readership?

Chile will maintain its leadership and see a portfolio of greenfield and brownfield projects that are lower-grade copper; the grades have decreased from 0.95% copper to 0.75% and could continue to decline, meaning that we need to enhance our technology to produce the same amount of copper.

Chile's vast array of commodities

Massive copper expansions take the spotlight, but there are other minerals.



Sampling alteration zones in the Atacama desert. (Photo by Steve Andersson, courtesy of Inmet).

Latin America attracted more exploration spending in 2010 than any other continent in the world, with a grand total of 27% of global non-ferrous exploration budgets being spent in the region. Five countries - Mexico, Peru, Chile, Brazil, and Argentina - accounted for all but 17% of this expenditure. Yet even within this elite group, Chile ranks exceptionally well. In the 2011 World Ex-

ploration Report from the Metals Economics Group (MEG) Chile rose from seventh to sixth in 2010 (one place higher than in 2009) with 5% of total expenditure. Moreover, the Fraser Institute Annual Survey of Mining Companies for 2011-2012, based on the perception of the main mining industry executives, estimated that Chile is the best jurisdiction to do mining in Latin America.

"Chile is recognized worldwide as a mining country since its territory is rich in metalliferous deposits, mainly copper, gold, silver, iron, lead, zinc and manganese. Most of these resources are located in the north of our country, which is characterized by the presence of vast types of deposits, with major porphyry copper deposits," said Enrique Valdivieso Valdés, former national director of Sernageomin, the governmental body in charge of the geological study of these deposits. Much of the country's mineral wealth has accumulated from volcanic and magmatic activity, as well as the extreme aridity that has prevailed over the Atacama Desert for millions of years. "Metallic mineral resources are the backbone of large-scale mining in Chile, where there is an ongoing exploration for copper, molybdenum, gold, silver, iron, lead, zinc and manganese," said Valdivieso.

For a relatively small country (its 756,096 km² are dwarfed by neighboring Argentina or regional giant Brazil, and rank as the seventh smallest on the continent), Chile boasts an impressive diversity of exploration activity. New technology is being applied to known deposits to seek unexploited potential, and greenfield exploration is being undertaken for a diverse range of other minerals.

Copper

As is to be expected, a large amount of exploration expenditure is focused on finding the most famous of Chile's minerals, copper. The promise of massive finds in a country that boasts the highest concentration of large copper porphyry deposits in the world has attracted a slew of both juniors and

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Patrick Cussen, chairman of the board, the Center for Copper and Mining Studies (CESCO)

majors, all seeking to find the next Chuquicamata or El Teniente." The Chilean Mining Code was last amended in the 1980s and is useful in many ways defining clearly Mining Rights, which gives all private companies a sense of security and has encouraged foreign companies to invest in Chile in the past three decades" said Patrick Cussen, chairman of the board of The Center for Copper and Mining Studies (CESCO), the Chilean think-tank on mining.

The history of exploration success in the Chilean copper belts can be reinvigorated with new technologies and concepts. Those who believe that the country's discovery potential for copper deposits could be exhausted, especially after a mining history that dates back centuries and a current crop of companies that have staked large land claims, are mistaken. "Chile has large copper deposits and potential for long-term exploitation. In general, Chile is a very good place to work. People abroad have the perception that in Chile there is not much land available anymore. The big established companies have a lot of it and the mining industry has reached maturity and there are some areas that are fully staked, so you have to be a bit more creative," said Friedrich Speidel, regional manager, South America for Inmet Mining, a Canadian-based mining company active in copper and zinc production, development and exploration that also owns operations in Turkey, Spain, Finland and a development project in Panama.

In Chile, Inmet Mining has two generative projects, 16 projects at the target generation stage or early drilling stage, and one project in the advanced drilling stage. The broad geographic distribution of these projects is a good indication of the extent of the country's geological promise. The company plans to have a broader portfolio of projects in both Chile and Peru within the next five years, with a larger focus on more advanced projects.

Iron Creek Capital is another Canadian company focused on Chile, with copper forming as an important component of their poly-metallic portfolio. Timothy Beale, Iron Creek's President said, "It is hard to beat the potential of the geology in the country as we are located along some of the world's most prospective mineral belts. Chile is a great place to be working in this business, and Iron Creek has properties with multiple targets in the existing portfolio, so we hope we have very good chances of discovery success. The potential is very good and the Maricunga district in Chile has a number of large projects with very important precious metals and copper resources, but generally with rather low grades. Also, there are some difficulties in these areas because of the high altitudes and the weather conditions in the winter."

Since communities in the north of the country are more accustomed to the mining industry, the relations with local communities in Chile in many cases are less conflicted than in other states of Latin America. "In terms of community relations, exploring in Chile is much easier than in Argentina," said Marcelo Cortés, projects development vice president of Coro Mining Corp., a Canadian company with an established exploration pipeline of copper and molybdenum projects in Chile and copper-gold ones in Argentina.

Friedrich Speidel from Inmet said, "The main challenge at the exploration stage is the mining code: it is very complex and I find it somewhat unpredictable and not very 'user-friendly'. Mining exploration do not have real title security until they finally constitute their properties. Industry people over the years have commented that they would like to see the mining code updated, but this has not yet happened.

Indeed the system of mining concessions in Chile allows companies to keep the areas of exploration by just paying an annual amount, and without committing to do any work on them. "In Chile this can be a problem, especially for junior companies. Indeed the system of mining concessions in Chile does not give as many opportunities to exploration for junior companies, as it allows large companies to keep the concessions for large, prospective areas of exploration by paying the annual fee and without need to show progress in exploration. That tends to discourage exploration by juniors because it can be difficult to negotiate with large companies upfront from the early stage of exploration," said Felipe Malbran, executive vice president exploration of South American Silver Corp. (SOAM), a Canadian junior

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company that is developing the copper-gold project Escalones in Chile, among other exploration projects.

In Chile and Latin America, SOAM Silver is focused on further development of silver and copper projects. "We have developed a specific expertise through our our Malku Khota project in Bolivia in terms of silver and indium, as well as significant experience in porphyry systems. The gold potential in Chile is great, though it has generally been associated with other minerals, generally with porphyry copper systems," said Malbran.

Future exploration projects in Chile could see more cooperation between large companies that own property rights and junior players, as is the case of the copper-gold project Inca de Oro, a joint venture between Codelco and the Australia-based company Pan Aust. "Pan Aust can bring know-how to Codelco and vice-versa. We expect many more joint-ventures like this one to happen in the future," said Francisco Tomic, executive general manager of Pan Aust, a copper and gold producer with operations in South East Asia.

Portfolio of investments 2011-2020

According to the Chilean Copper Commission (COCHILCO), Chile has a robust mining investment project portfolio until 2020,

valued at US\$66.8 billion. This amount includes projects under construction and projects slated to begin construction in 2011 to 2015, plus portions to be invested from 2015 to startup.

Investments slated for 2011 to 2015 stand at US\$44.1 billion, 66% of the project portfolio. Planned investment in copper mining stands at US\$54.3 billion, or 81.2% of the total. The balance goes to gold and silver mining with US\$9.82 billion or 14.7% and to iron and industrial minerals mining with US\$2.71 billion or 4.1%.

Major copper producers

COCHILCO's projections for the period 2009 to 2025 indicate that copper production will see a dramatic jump, rising by about 45% as a result of construction projects worth US\$20.8 billion. Furthermore, the development of new deposits could further enhance the productivity of the industry, averaging 7 million mt/y by 2025.

Codelco, the state-owned Chilean group, is the world's single biggest copper producer, controlling about 20% of total global reserves. The state-owned giant accounts for 45% while major private miners account for 53.5% of copper-mining investment. "Codelco plans to invest US\$3.5 billion every year over the next six years, which is a

third of the total investment portfolio that we have in Chile," said Diego Hernández, President and CEO of Codelco. As explained by Diego Hernández, some of Codelco's mines have been in production for years and therefore are running out of oxide ore or have lower-grades. The same is happening in the case of mines owned by other large players. Similar to Codelco, major private mining companies need to plan massive investments in mine expansions.

The new projects of private mining companies in Chile are not far behind Codelco's in magnitude. Esperanza, inaugurated last year and owned by Antofagasta Minerals, had a construction cost of US\$2.6 billion, according to Marcelo Awad, Antofagasta Minerals' (AMSA) President and CEO.

"Antofagasta Minerals' production will grow thanks to the Caracoles and Telégrafo projects, which also produce gold, and by expanding the Pelambres mine, which produces copper, gold and molybdenum. The company plans to double its production by 2020 thanks to an ambitious investment plan of US\$15 billion," said Awad.

"Antofagasta Minerals has a project portfolio that will allow doubling our capacity by the end of this decade, considering only national operations. We have two international projects, one in Pakistan and another in



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Marcelo Awad, President and CEO, Antofagasta Minerals.

Minnesota, United States called Nokomis, which will take from three to 10 years to be built. The open pit mine project at Antucoya is waiting for director's approval, and will contribute a further 80,000 mt/y by 2014. Also, by the end of 2016, we will have two other projects, Caracoles and Telégrafo, which will together contribute 350,000 mt/y of copper. For Los Pelambres we also have projected to double production; we are now on the pre-feasibility stage, and it will take around seven years to bring to operation. Today, we also produce 250,000 oz/y of gold per year and, when the new projects come in, we should produce around the 600,000 oz/y. Molybdenum production should rise from 10,000 mt/y to 25,000 mt/y before the end of the decade," said Marcelo Awad.

Collahuasi, owned by Xstrata (44%), Anglo American (44%) and Mitsui (12%), is another giant mine in expansion. "The expansion of Collahuasi, which is now at the level of feasibility study, will double the mine's production. Today Collahuasi produces about 500,000 mt/y of fine copper, and with the expansion it could produce more than 1 million mt/y," said Miguel Ángel Durán, executive president of Anglo American Chile.

Collahuasi's total investment for expansion phases I and II will reach US\$3.2 billion. The project involves building two reverse osmosis potable water plants and two wastewater treatment plants. The company also plans to build an organic material landfill, a modular water treatment plant and landfill for non-hazardous waste.

BHP Billiton Escondida's expansion is another huge project, which will probably reach US\$5 billion in investment. The enlargement will include a third concentrator and increase production to 1.3 million mt/y, aimed to reverse an ageing operation that has seen BHP Billiton's copper production decline 7% during 2011, due to lower



Miguel Ángel Durán, executive president of Anglo American Chile.

volume from the Escondida mine in Chile. BHP said output at Escondida is expected to be marginally lower in the year through to June, with volumes weighted to the second half of the year, but should improve beyond that as mining moves toward higher-grade ore. BHP has a 57.5% stake in Chile's Escondida mine, which is one of the largest producing copper mines in the world.

Moreover, the original BHP Billiton's Laguna Seca plant project was complemented by a new mill and concentrating plant replacing the Los Colorados facility, to be relocated to clear the area for new mining. These plans are designed to retain current concentrate output in spite of declining grades. A new phase to be defined may consider the construction of a third concentrating plant plus a desalination plant supplying water to the new operations.

Anglo American has invested around US\$2.8 billion in the Los Bronces (Anglo American Sur) development. "Los Bronces is currently in the start-up curve. After 12 months we will reach the total installed capacity, which will be up to 400,000 mt/y of copper. The expansion included the purchase of a crusher and a new milling line with a capacity of 87,000 mt/d processing plus a 58-km long slurry pipeline for transportation of ores to higher-capacity copper and molybdenum concentrating plants in the valley. At peak production levels, Los Bronces is expected to be the fifth largest copper mine in the world, with reserves and resources that support a mine life of more than 30 years and with further expansion potential. We are driving volume growth across the most attractive commodities with a continued focus on long life assets with low cash operating costs. Our long-term growth pipeline presents significant opportunities and optionality," said Durán of Anglo American. Anglo American produced 599,000 mt of fine copper in 2011. "Anglo American is also studying

the possibility of expansion of its other projects in Chile: Mantos Blancos, El Soldado and Mantoverde. In Mantoverde we are developing to allow sulfide minerals to be extracted. Mantoverde has oxide ores that can produce 60,000 mt/y of fine copper until 2016. Anglo American intends to extend Mantoverde's life until 2032 through the sulfides. Moreover, Anglo American invests on exploration for new deposits in Chile," said Durán.

Quadra FNX Mining will invest US\$2.5 billion in the development of the Sierra Gorda deposit, as exploration suggests the presence of major copper, gold and molybdenum reserves. The Canadian-based company decided to wind down its Carlota and Podolsky operations to focus on more promising projects and also made changes to the mining plan for its Franke mine in Chile. Quadra FNX sold a 45% stake of its Sierra Gorda copper project to Japanese company Sumitomo Corp.

Complementing the projects of players that are already established on the Chilean market, such as Xstrata (expansion of Lomas Bayas), Teck (Quebrada Blanca Hipogeno) and Freeport Mc Moran (El Abra Sulfolix), there are also new operations owned by new players, such as Pan Pacific Copper (PPC), a private Japanese company held by JX Nippon Mining & Metals and Mitsui Mining that invested in Chile to guarantee the copper supply to its two smelting plants in Japan.

PPC and Mistui Co., Ltd jointly own Minera Lumina Copper Chile with a share balance of 75% and 25%. In Chile, JX Nippon Mining & Metals has a share of 15% in Minera Los Pelambres, 3.6% in the Collahuasi mine and 3% in Minera Escondida, the biggest copper mine in the world.

"To increase our supply ratio, Minera Lumina Copper Chile is currently developing the Caserones copper and molybdenum project in the north of Chile, the first project fully operated by Pan Pacific Copper. We plan to start producing copper cathode in January 2013 and copper and molybdenum concentrate by the end of 2013," said Masashi Kikuchi, vice general manager of Minera Lumina Copper Chile.

Despite the long history of copper extraction, the future of Chilean copper production and its leading global position is guaranteed by the plans for increased production of the major mining companies, both public and private, which will assure the maintenance of the world's first position for at least 15 years. Copper is a key wealth for Chile, and can finance almost 50% of the country's budget.



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Orosur Mining Inc. is a fully integrated gold producer and exploration company focused on identifying and developing gold projects in Latin America. The Company operates San Gregorio gold mine in Uruguay and has a portfolio of high quality exploration and development assets in Chile.

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Gold

Gold production in Chile will grow 19% from 2011 to 2015, cementing the country's position as a significant producer of the precious metal. The field for foreign gold explorers and producers is wide open, with no national champion dominating the gold mining industry to the same degree as Codelco does in copper mining. In Chile, gold is often associated with porphyry copper, so gold companies need to extract both minerals.

Exploration

"The potential for gold exploration in Chile is great. If you look at the growth profile, the current projection is for 200% to 300% growth in the next five years. There are some very big projects that should be developed in the next five to 10 years, for example, in the Maricunga belt where Andina Minerals has discovered 17 million oz and is currently completing its feasibility study. The Maricunga gold belt is characterized by very large lower-grade deposits that have become more attractive with the world's depleted resources," said George Bee, CEO of Andina Minerals, a Canadian gold exploration company focused on Chile.

"Chile will likely go from being the 15th biggest gold producer in the world to the eighth biggest gold producer," said David Fowler, Orosur Mining's CEO.

Orosur, which operates a producing gold mine in Uruguay (San Gregorio), has assembled an exploration portfolio of high-quality assets in Chile. The Canadian junior company started working in Chile three years ago after acquiring a Canadian company called Fortune Valley, which had two projects, one with Codelco and another project with Anglo American. "For us, it was a good combination of new exploration projects and starting in Chile with an established company. Having acquired those two assets, we recently acquired our third asset, Talca. Orosur's goal is to maximize our market valuation based on what we have at the moment, to grow the company, develop our assets, and increase the value of what we have. We want to be seen as a production company. That is why we are doing exploration to try and grow the production. In five years, we expect to have developed two of the new projects and we will be producing 150,000 oz/y if not more," said Fowler.

The aforementioned Iron Creek Capital has taken a very specific approach to gold and silver exploration, looking to bolster their copper resources with significant finds in these commodities. "Iron Creek geologists have particular expertise in the exploration for precious metal veins of the El Peñón type and we feel that these are very valid targets in this part of the world," said Beale.

South American Silver Corp. (SOAM) provides a typical example of the type of gold mineralization found in Chile. Their Escalones project is a copper-gold porphyry project with a resource of 420 million mt containing 3.8 billion lbs of copper; they are now begin-



Orosur's San Gregorio mine is located in northern Uruguay in the historic Minas de Corrales mining district. (Photo courtesy of Orosur).



David Fowler, CEO, Orosur Mining.



La Coipa mine, located in Copiapó, northern Chile. (Photo courtesy of Kinross).

ning a second phase of drilling and are looking to complete their first engineering assessment later in 2012. "For me the gold potential in Chile is great, though it has generally been associated with other minerals, generally with porphyry copper systems, but not as in Mexico, Peru and Bolivia where it's the primary mineral," said Felipe Malbran, executive vice-president of exploration.

Producers

Having bought gold deposits in Brazil, Chile and Ecuador, Kinross has changed from being a minor joint venture partner into the operator of projects over the years. Lobo-Marte is a gold project in northern Chile, which is the company's flagship in the country. "With the increasing price of gold, the ability to mine greater depths and improving technology, gold mines are staying in production for longer. The expected mine life of Lobo-Marte is 10 years, but there are significant other potential targets in the area. We have an exploration program looking at other targets within a 10- to 15-km range of Lobo-Marte on the package of ground that we have. The property was an acquisition from Teck Cominco and certain subsidiaries of Anglo American. Lobo-Marte used to operate in the early 1990s and the original Marte mine was built and shut down within a year of operations. The construction of Lobo-Marte should start in September 2012 and will take 18 months. The expected production of the mine could be as much as 320,000 oz/y and this project is our main focus," said Alan Pangbourne, vice-president of projects South America, Kinross.

Other major gold projects in Chile include the Cerro Casale project (Barrick), Caspiche (Exeter), El Morro (Goldcorp) and Pantanillo (Orosur Mining).

Barrick's operation Pascua-Lama, which is located on the border of Chile and Argentina, has proven and probable reserves of 17.8 million oz of gold, with 671 million oz of silver contained within the gold reserves. Pascua-Lama is a high quality, world class resource and it is expected to have an average annual gold production of 800,000 to 850,000 ounces in the first full five years of operation.

Pascua-Lama, located over 4,500 meters of altitude, will create more than 5,000 direct jobs in the region. Barrick Gold, the world's largest gold producer, is committed to manage the project in a responsible manner. "Barrick is committed to making a positive difference in the communities in which we operate. These communities benefit from jobs, salaries, capital expenditures, local purchase of goods and services, and payment of taxes and royalties. In Chile we have been working over the last three years in the Atacama Commitment, an innovative partnership between the company and a group of Chilean NGOs and governmental agencies. The Atacama Commitment is a unique alliance with eight Chilean

NGOs, the UN Global Compact and government partners focused on economic and social conditions by addressing their root causes: lack of educational resources, poverty, and poor housing conditions," said Rod Jiménez, Barrick's vice president corporate affairs in South America.

It is not, however, only the majors who are producing in Chile. The favourable business climate has allowed a number of companies to become producers. Cerro Grande Mining Corp., for example, is a Canadian-based company that has achieved success as a gold, copper and industrial mineral developer and producer in northern Chile. "The company's Pimentón gold-copper mine is in production since 2004 and has an expected life of 50 years. The potential for the Pimenton mine is huge, although it will take time to increase the tonnage. Exploration is going deeper and our rig is capable of drilling to 1,500 m. Depending on our results, we will have to go

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The Pimenton Gold mine produced 14,085 ounces for fiscal year ended September 30, 2011 and expects to increase production to +/- 20,000 gold ounces in fiscal 2012 with further increases thereafter.

Currently drilling the Pimenton porphyry deposit which is located in the central porphyry copper belt of Chile and lies 15 km to the north east of Anglo American /Xtrata's West Wall Project which has a reported 750 MT of inferred resources grading 0.54% Cu, 0.01% Mo and 0.05 g/t of gold containing 4.0 million tonnes of copper using a 0.03% copper cut-off grade.

Currently drilling the Santa Cecilia Project which is located in the Maricunga District of Chile and adjacent to Exeter Resources Caspiche Project which has NI 43-101 compliant resources of 26.4 M oz gold, 6.7 B lb copper and 62.9 M oz silver.

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Kinross owns and operates two major gold mines in Chile – Maricunga and La Coipa – and holds a 100% interest in the high-potential Lobo Marte project. With a long and proud mining heritage, Chile is a great place to do business and an important part of our company's future.

Kinross is committed to being an outstanding corporate citizen and good neighbour, and to us that means protecting the safety of our more than 1000 Chilean employees, being environmentally responsible, and building positive relationships with our host communities.

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Kinross is a Canadian-based gold mining company with mines in the United States, Brazil, Russia and Chile, and approximately 5,000 employees worldwide. Kinross is listed on the Toronto Stock Exchange (symbol:K) and the New York Stock Exchange (symbol:KGC).



Barrick Gold's Zaldívar copper operation in northern Chile. (Photo courtesy of Barrick).

to the market to find US\$25 to US\$30 million to drill, but we are currently funding our own drilling," said David Thomson, executive vice president and director of exploration of Cerro Grande Mining Corp.

Iron

In 2011, Chile produced 0.38% of the world's iron production ranking far behind the world leaders. In 2010, the main iron player in Chile, CAP Minería, increased production by 23%, reaching 10.5 million mt. "We hope to double production in the next five years," said Peter Venturini, manager of mining projects in the CAP Group, which is constantly expanding its mining programs to ensure the continuity of operations for many decades to come.

Among the iron producers, Minera Santa Fe is a company dedicated to extraction, concentration, smelting and export of iron ore products. The company, a joint venture with India's JSW Group, produced 1 million mt in 2011. At present their main exploitation comes from iron of their mines situated in the Third Region in Chile.

Molybdenum

In addition to its growing gold output, Chile is also the third largest producer of molybdenum in the world, behind China and the United States with about 17% of the global production, according to Cochilco. In terms of exports, molybdenum is the second most important mineral in the country. In 2010, Chile exported 39,896 mt valued at US\$1.322 billion. Of this amount, more than 50% has been produced by Codelco, while the rest of the production comes from Collahuasi, Los Pelambres and Anglo American.

Non-metallic minerals

Chile has large investments in non-metallic minerals. In 2010 Chilean exports of these products achieved a value of US\$1.622



RC drilling at the Cerro Buenos Aires exploration target, Pampa Buenos Aires project. (Photo courtesy of Iron Creek).

billion. More than half of this figure is represented by the production of deposits such as caliche, mainly iodine and its derivatives (US\$407 million) and salt (US\$444 million including potassium nitrate). The potassium salts (chloride and sulfate) provide 22% of the total value of Chilean non-metallic production.

The importance of non-metallic resources in Chile is based on their variety and quality and also the massive nature of some of the reserves. Chile possesses more than one third of the world's iodine, as well as vast amounts of natural nitrates and gypsum/anhydrite. The exceptionally large salt deposit of Salar Grande has reserves that could supply world demand for centuries. Chile is therefore today a world leader in the production and export of lithium, iodine and nitrate ore as well as the main producer of salt.

"Chile suffers from a lack of well located high-grade limestone deposits. In recognition of this shortage and the fact that there exist substantial growth opportunities for the consumption of burnt lime, CGM has re-focused part of its exploration activities and knowledge of the Chilean mining industry to identify potential burnt lime projects," said Stephen Houghton, CEO of Cerro Grande Mining Corp.

Cerro Grande Mining's primary industrial minerals deposit is the Catedral/Rino project, a limestone and cement rock deposit. These kind of deposits "are hard to find in Chile in sufficient volumes. Currently there are three major producers who have not been interested in the cement rock deposit but we think that the deposit will be a major player in time."

This deposit, while useful in its own right, is particularly beneficial when viewed in conjunction with Cerro Grande Mining's other projects. "We are seeking to find a source of capital or a partner who would put the cement rock deposit into production. However, we have been advised to keep the limestone deposit because the porphyry

development at Pimenton will require limestone and it will be beneficial for us to have our own source," said Houghton.

Chile, the Saudi Arabia of lithium

Alongside these commodities, lithium is an area in which Chile really makes a mark on the world stage. According to the U.S. Geological Survey, the Atacama desert contains 27% of the world's lithium reserves. "Chile contributes more than 50% of lithium for chemicals production worldwide, and is a leader in price. There is no permit yet in Chile to exploit lithium, since it is legally a

strategic mineral. This definition dates back from the time when lithium was thought to be used in the production of nuclear weapons, and is now considered to be outdated. Only two companies, the local SQM and the German firm Chemetall's subsidiary Sociedad Chilena de Litio, operate in the country," said Daniela Desormeaux, founder of Signum Box, a consultancy that offers market intelligence specialized on the lithium market.

However, companies such as Li3 Energy, Australian Talison Lithium and US-based Pan American Lithium are currently exploring for lithium in Chile.


Li3 Energy, a US-listed and South American based exploration and development company in the lithium and minerals sector acquired their flagship asset, Maricunga, in 2009. "Li3 has a preliminary mine plan, in which we expect to produce 15,000 mt/yr of lithium carbonate during 20 years. So in total, we should have a resource of approximately 300,000 mt of lithium carbonate. We are now working on a preliminary economic assessment, which will come out in early March 2012. We expect to be in production in early 2014," said Luis Sáenz, Li3 Energy's CEO.

Sáenz, who is planning to list the company on the Toronto Stock Exchange before mid-2012, explained his ambitious plan:

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NI 43-101 "Property of Merit" (Hains Technology & Associates) - June 2011

Strategic Partnership (POSCO) - August 2011

Executed \$8 MM Phase One of \$18 MM Exploration & Development Plan - September 2011

Top 5 Lithium Salar in the World (signumBOX) - Dec 2011

Exploring Disruptive Evaporative Technology (R3 Fusion) - Jan 2012



li3energy.com info@li3energy.com



Operations at the Maricunga project, northern Chile. (Photo courtesy of Li3).

"Li3 has the right access, the right people and the right partner. That differentiates us from many other players. In Argentina there are many lithium projects ahead of us in their investigations. Nonetheless, because of the work we are doing here in Chile and our long-term strategic investors, we are catching up very quickly. In the long-term, Bolivia, which owns about half of the world's resources in lithium, will be the place to be for lithium mining. However, the Bolivian government is very reluctant to let foreign investors in. To be able to invest in lithium in Bolivia you have to think long-term, and a lot of time and potentially money will be spent in talking to the Bolivian government to come to a solution that works for everyone. We want to show the government that they can use their natural resources to change the dynamics of the country, which is one of the poorest of Latin America. POSCO, our partner, is one of the companies that have signed a memorandum of understanding to develop projects in the Salar de Uyuni in Bolivia."

"We know that the Chilean authorities are currently examining the regulations to make future lithium exploitation possible," said Sáenz. Salt lagoons, as the ones present in the Atacama Desert, have proven to be cheaper to exploit compared to a conventional mining process and as such have given Chile a cost competitive advantage in lithium production.

In the lagoons, lithium is found in the form of lithium chloride, which is transformed to lithium carbonate with solar evaporation. The chloride is pumped, placed in evaporation wells, using solar energy; the only energy costs come from pumping from 5- to 50-m deep. It is then transported to the chemical plant and mixed with different chemicals and dried to obtain lithium carbonate. This process is very cost efficient compared to the mining process; the cost per mt is around US\$1,300 to US\$2,000/mt, although the economical evaluation is complicated due to the fact that, when producing lithium hydroxide, the carbonate is produced first and then mixed with sodium hydroxide. Therefore, the production costs of the lithium carbonate must be taken into account, unlike the mining companies, who can produce from the concentrate both carbonate and hydroxide.

The lithium market is currently dominated by a handful of major producers, SQM and Chemetall, but investors naturally look to smaller junior exploration and production (E&P) companies for the real growth. As the demand for battery-powered devices increases, global demand for lithium has risen, bringing the Chilean industry forward to international prominence.

Evolution and Challenges

How Obstacles Breed Innovation



3M is a major supplier of safety, chemical and electrical equipment. (Photo courtesy of 3M).

To take full advantage of Chile's mining boom, which will see copper output rise to 7 million mt/y by 2015, the industry is going to have to overcome energy, water and skilled labor deficit challenges that are already hampering the speed at which new output can be brought on line. These challenges are motivating companies to develop new innovations and technologies.

Water

With most mineable deposits in Chile being located in the north of the country, one of the driest places on earth, some of the obstacles facing the mining industry are no surprise. "One of main challenges is related to the availability of water in Northern Chile, where most of the mining operations take place," said Miguel Ángel Durán, Anglo American's executive president, Chile.

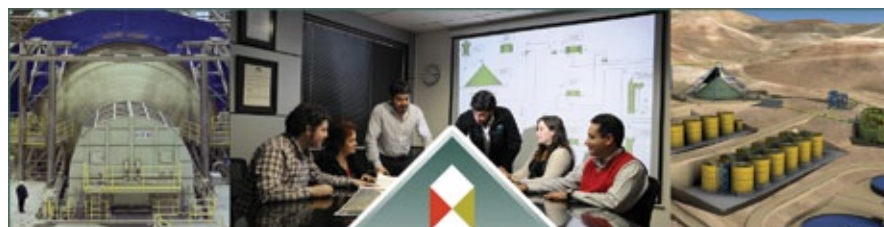
With limited water availability, this resource has taken on a critical importance. High cost and the potential impact of climate change on water resources must be factored into a company's strategy from the start of any operation. "PWC is helping one of the biggest mines in Chile with water management to ensure that it is economically optimal. The water usage is measured in each part of the process in small segments to help understand the economical implications," said Colin Becker, partner at PricewaterhouseCoopers, in an example of the amount of care that companies have to pay to this issue.

According to Cochilco, the total amount of water consumption for the production of copper concentrates will increase to 540.6 million m³ by 2020, 26% more than current volumes. For copper production, water is used mainly in the traditional processes

of concentration by flotation, fusion, electro-refining, hydrometallurgical process leaching, solvent extraction and electro-winning. "In mining, most water is spent in the tailings. Fortunately, more wastewater gets recovered nowadays: tailing thickeners are better, recovering more water and preventing heavy metals from infiltrating the soil. The tailing ponds are smaller, and therefore have a lower evaporation rate,

because of their surface. Evaporation is a big issue in Chile, since many mines are located in the desert," said Leticia Conca Benito, general manager of Alquimia Conceptos, a consultancy focused on mining and metallurgical processes.

Ricardo Nicolau, managing director of Chilean engineering firm JRI Ingenieria, agrees on the importance of new technologies to improve water management. "The



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Ricardo Nicolau, managing director, JRI Ingeniería.

mining industry is trying to recover as much water as possible from the tailings. We have a lab where we study how to thicken tailings,” said Nicolau.

Mining companies have traditionally obtained water from aquifers. However, the scarcity of fresh water from the main land and competition for it with other productive sectors, such as agriculture and manufacturing, has led mining companies to look at alternatives. Mining companies are making innovative efforts in this sense, such as the use of seawater via desalination, water recirculation and innovative waste disposal solutions.

“At Esperanza, Antofagasta Minerals has three important innovations which have been applied for the first time on a large scale. We are pumping seawater to an altitude of 2,400 m, with four pumping stations in 120 km of tubing. Moreover, we are not desalinating water, as we use salt water for all of our processes, becoming the first copper operation to do so completely. The third innovation is thickened tailings, which are the first in Chile, and second worldwide after Australia. The thickened tailings use less volume, and recover most of the water. Unlike most tailing wells, the solid percentage is 70% with 30% water, and all recovered water is reused in our processes,” said Marcelo Awad, CEO of Antofagasta Minerals, one of the main copper producers in Chile.

The desalination process is costly, as processes such as reverse osmosis require a significant amount of energy. Moreover, seawater is usually found far from the mine sites. In the feasibility study, mining companies need to take this into account or look at other technologies to save water. “In some cases desalination is an option and in other cases it becomes financially limiting as it requires huge amounts of energy. We have been looking at new ways to increase water capture and we have been



Alan Pangbourne, vice-president of projects South America, Kinross.

doing tests with snow fences to increase water capture,” said Alan Pangbourne, vice-president of projects South America, Kinross, a major gold exploration and production company.

The competitive advantage of using salt water is a significant lowering of costs and, in addition, when water is desalted, it generates large amounts of salt that need to be returned to sea or re-used. Using fresh underground water would risk exhausting the desert’s natural resources, but salt water gives long sustainability to the project.

“We do our own water management. We spent two years investigating the be-



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María Eugenia Parot, general manager, Golder Associates Chile.

havior of our minerals comparing sea water to fresh water and came to the conclusion that we obtained better results of recovering copper and gold from the Esperanza mine with pure sea water," said Awad of Antofagasta Minerals.

Technological responses to the water scarcity issues are increasingly sophisticated and national and international engineering companies work intensively to find new solutions. "We help our clients to work with environmentally sustainable resources and we are specialized in the issues of de-watering and retrieving water from tailings: we facilitate anything to prevent that water used

in mining operations contaminates the soil. We use sophisticated software to monitor these processes," said María Eugenia Parot, general manager of Golder Associates Chile, a global engineering firm with several areas of practice.

Energy

Water is not the only fundamental resource in short supply. Another major challenge for the development of the Chilean mining industry is its ability to secure sufficient power. Although energy infrastructure is growing, the number of mining projects in the pipeline makes their development a race against time.

According to Chile's President Piñera, at the rate the country is growing there is the need to increase its installed capacity by 8,000 MW to address the rise in consumption that will accompany investments planned until 2020. The country currently has about 17,000 MW of installed capacity, of which more than half is consumed in the Central Interconnected System (SIC), and about one third in the Northern Interconnected System (SING).

In terms of energy consumption, the mining industry ranks first in consumption of electricity in the country, and in terms of total energy is the fourth after transport, the

residential sector and manufacturing sector, according to the National Energy Commission (CNE).

At present, electricity prices in Chile amount to US\$250 per MWh, which is US\$50 per MWh higher than those in Argentina, Colombia and Peru. These high prices have an historical reason; during the Argentine energy crisis in 2004, the Argentinean government restricted natural gas exports to Brazil, Chile and Uruguay to preserve the supply for internal consumption. These export cuts seriously harmed Chile and since then the electricity sector in Chile relies predominantly on thermal and hydro-power generation.

In this context, the mining industry faces increases in its cost structure in direct relation to electricity prices. "Higher energy prices in Chile reduce the country's competitiveness in all the economic sectors and mining is no exception," said Durán of Anglo American.

Faced with this situation, mining companies are making efforts related to energy efficiency and clean technologies, and are exploring initiatives to promote non-conventional renewable energies. "The main backbone of the grid is reaching capacity and the entire grid is becoming stressed so we are getting power cuts and brownouts. How-

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ever, there is work being done and power stations have been approved and there are new hydro-stations being built in the south. Development requires power and the options for power development are limited," said Pangbourne of Kinross.

"Antofagasta Minerals is developing two power supply types. The first is geothermal energy and we have several contracts in this area. Our most advanced project of this type is located 300 km southeast of Santiago, where we have drilled 700 m deep and managed to obtain water steam to the temperature that allows us to keep drilling and get to the 1,500 m needed to place the turbine and generate electricity. We will be done with the project at the end of 2013. The second type of power supply project that Antofagasta Minerals is developing is underground coal gasification: we take coal deposits and, instead of extracting the coal, we inject oxygen and ignite it; the flame burns the coal which generates a methane gas that is captured at the surface with tanks, and later distributed and used in thermo electrical plants or for domestic use in cities. This operation is run in Valdivia," said Awad of Antofagasta Minerals, in an example of the innovations companies are exploring.

The importance of developing these alternative sources to complement more



John Byrne, managing director, Boyden.

conventional sources of energy has been emphasized by a number of the country's leading figures and analysts. "With coal-power energy becoming more expensive and diesel power capacity still a number of years away, we may see the industry shifting into alternative energy as both a complementary source and as a manner of complying with social responsibility standards," said Alicia Domínguez, leading partner of Ernst & Young's mining group in Chile.

Mining companies that are already connected to traditional power generators are now requesting to be connected to alternative renewable energy sources. These renewable energy providers are making sales

contracts with the mining companies to help provide some of their energy needs. "We have been watching closely what has been going on in Europe in terms of the increasing focus on the issue of renewable energy. Now, we are looking at our own systems to see where we can begin applying more alternative energy sources. A new network can take five years to set up. Hopefully, within five years, we will already be relying more on renewable sources. We are constantly considering new options in terms of alternative energy sources as well as advances in traditional technologies," said Eric Ahumada Gómez, business development vice president of transmission company Transelec.

In addition to these efforts, many of the engineering companies heavily involved in the mining industry are also seeing a gap in the energy market and are moving in to meet this demand. Endress+Hauser, known worldwide for their work in the energy sector, are increasingly looking to supplement their work in Chile's mining industry. "For Endress+Hauser worldwide the energy sector is a large part of the business. In Chile, we want to work alongside engineering companies to cover the energy area; we want to develop the area of energetic resources optimization. It begins by knowing how much is consumed, monitoring the consumption, with certain software, and review afterwards," said Susana Torres, managing director of Endress+Hauser.

The mining sector uses 85% of the Northern Grid's (SING) power capacity of which 58% is supplied by natural gas. To expand copper production by an order of a magnitude as discussed earlier, Chile will have to reconcile the construction of new large scale power plants and fuel sources (coal, natural gas, and uranium).

Skills shortage

According to Ernst and Young, a skills shortage remains the second biggest risk for mining and metals this year in Australia, Latin America, South Africa and Canada. "In Chile, there is an incredible demand for knowledgeable people in terms of project control managers, project directors and plant managers. The demand is in the mining sector but also in infrastructure. Brazil hires anyone that they can find that is associated with engineering. Chile will receive US\$67 billion of investment in mining alone and Peru will receive US\$48 billion by 2020; each project needs available people," said John Byrne, managing director of Boyden, one of the three main recruitment companies present in the country.



Lines of Transelec in the flowered desert in the north of Chile. (Photo courtesy of Transelec).

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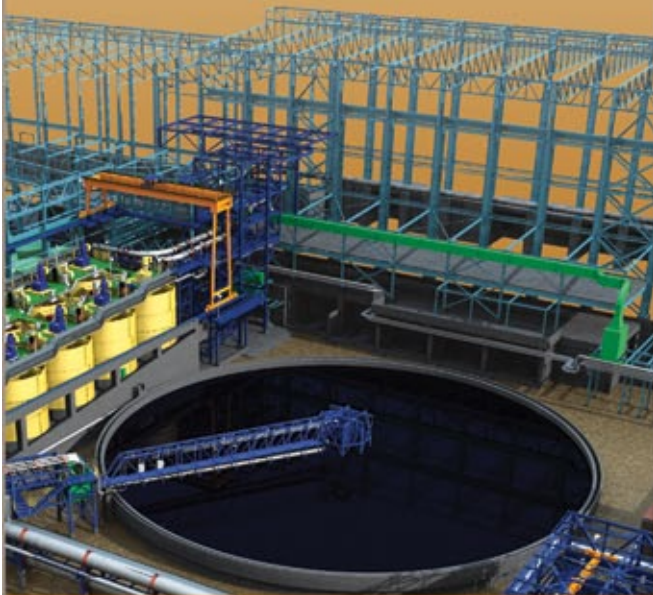
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The selection process used by Boyden tries to define the specifics of the required positions. "We visit the place of work to meet and discuss with HR and line managers to gain a greater understanding of what exactly they are looking for. We define a target market where we research on specific candidates. In the second week we have initial meetings with the selected candidates. By the third week we deliver our clients with a long list and meet with our client and by week four we deliver candidates. We always try to be within four weeks and we measure a lot of key performance indicators in the company; our period to fill is 120 days, which is a good turnover ratio," said Byrne.

In Chile, the Institute of Mining Engineers (IIMCh) has estimated that the mining sector in the coming years will face a human capital deficit that could reach 64,000, considering only the most feasible projects that could materialize in the medium term.

"The deficit of miners can be explained by the combination of a considerable increase in demand for workers from geo-mining and metals companies (attached to the copper boom of recent years) and a constrained supply growth," said Andrés Mac-Lean Vergara, executive vice president of COCHILCO.

"One of our biggest challenges is probably finding the number of workers we need to meet our expected growth. The education system in Chile just does not produce the necessary amount of people with the skills required for the mining industry. It is surprising that a country as dependent on mining as Chile does not focus more on supplying the human resources for the industry. If you talk to young people in Chile today, almost none of them say 'I want to be a mining engineer' or 'I want to be a metallurgist or a geologist'," said Jeff Dawes, President of Komatsu, a mining and construction equipment manufacturer.

According to figures compiled by Codelco, very few students in Chile choose a career in mining. Some reasons outlined include the distance to the job sites, difficulties in working in the mines, poor image of the sector and discontinuous financial support to students. "Right now the lack of specialized people due to the high market demand is a major challenge for the industry. Meeting dates and quality in a highly demanding market requires special skills from our people and organizations," said Martin Brenner, general manager of ThyssenKrupp Ingeniería Chile, a diversified engineering group.



Tailing dam engineered by JRI Ingenieria. (Photo courtesy of JRI).



Ricardo Garib, South American regional director, Weir Minerals.

To comply with this important issue, many companies are opening their own training centers or sub-contracting training programs. "A lot of mining companies and suppliers for the industry have to make our own arrangements. Komatsu Chile has recruitment and development programs internally so we can find people and train them. We also have our own university. We work with young people just out of 3- or 4-year programs, people from other industries, and even with our own people, as the rate of development and evolution in products requires a lot of training and re-training. The machines we use are very sophisticated. We have arrangements with technical institutes and universities throughout Chile. One of our main goals now is to try to entice young people from the south of Chile to pursue careers in mining. The vast majority of technical workers are generated in the south and central part of the country. The problem is that a lot of people are not interested in going to work in the north. We have to not only find people to train, but also convince them that their career really should be in mining," said Dawes.

PWC has found that their clients have taken a similar course of action. "We have been hired by a mining company to develop a mining school for professionals and technicians in the north of the country. One of the main challenges is to get skilled resources and females to work in the industry as it is not perceived as female friendly. Young people do not want to live in areas that are not popular, so we are working in collaboration with universities, to develop programs to attract young people to the mining industry and show them the benefits that the industry can provide. Our aim is to convince young people that the mining sector offers a good career choice," said Colin Becker, partner at PWC.

Recruitment from a pool of international talent is often the only solution. "We are forced to bring in people from Europe and Australia to fill the gap. The mining industry is global and people in the industry are mobile and understand that being flexible is part of the job," said Byrne of Boyden.

According to Cochilco, this situation has had, and will continue to have, an impact on the wages of experienced professionals and will provide an incentive to the replacement of national professionals with international ones.

"We also recruit people to work in Chile from Argentina, Peru and Mexico. Sometimes, there can be difficulties because someone might miss the food or customs from their home country, but we can usually work through it. The great thing about Chile is the people, but we are also seeing a lot of potential in workers coming out of these other countries," said Ricardo Garib, South American regional director of Weir Minerals, an equipment provider.

Those companies that overcome this challenge find themselves in a hugely advantageous position; explaining the priority that both mining companies and service companies put on finding new talent. "Profitability is essential, but this is not the company's baseline motive. A large part of JRI centres on the training and empowerment of our young engineers. We have just hired a university professor of metallurgy to train our employees to be qualified in more specific mining processes. While JRI gains from having educated engineers, highly skilled in the mining sector, these young engineers gain by receiving further education into the sector. This also obviously puts JRI at the cutting edge of new developments and gives an indication to the vision we have for future growth within the company," said Ricardo Nicolau, managing director of JRI, a Chilean engineering company that has grown from two to 400 employees in the past 30 years.

The mining sector pays high wages; well above the national average in Chile. The supply of an adequate quantity and quality of workers will be a strategic factor for the future competitiveness of the industry.

Safety

The importance of having highly skilled professionals working in the mining industry is also related to safety standards. Since the accident at the San José mine in 2010, where 33 miners were trapped underground for 70 days, the Chilean mining industry has raised its awareness of mining safety.

A year after the accident, measures taken by the government of Sebastián Piñera seem to have taken effect. The number of fatal accidents has fallen; the fatalities rate in 2011 had been reduced by more than 50% compared to 2010.

"The San Jose mine rescue exposed a lack of governmental control and now there has been much more focus on safety standards in the industry. Some clients are not prepared to pay extra for high standards, although global standards will be implemented by multi-national companies, which will increase industry costs, so we will be more financially competitive with local contractors," said Graham Buttenshaw, senior vice president for Redpath, a Canadian mining contractor specialized in underground mines.

For some, this increased emphasis on safety is providing them with a competitive advantage. "We were invited to come to Chile because of our extremely good safety record in such a dangerous industry. We have never had a fatality in the Americas. It is a very dangerous business when you build shafts and tunnels and safety is absolutely paramount in everything we do. Our biggest marketing tool is our safety record and that is why we get big, complicated, and high cost jobs," said Mark Venning, general manager of Cementation, a South African contractor who is expanding in Chile.

Due to the increasing importance of safety aspects in mining operations, protection equipment for workers has become an attractive business for various companies. 3M, a major supplier of safety equipment as well as chemical and electrical equipment, expects to double the size of their mining business in Chile within two years. "In terms of safety, we offer helmets, safety goggles - everything from respirators to reflectors. We work closely with regulating committees, the Mining Council and providers," said Guillermo Ochoa, 3M's general manager. On the top of a variety of tools and software to support miners' personal protective equipment (PPE), 3M organizes safety training for its clients' employees.

"For ThyssenKrupp, the health and safety of employees is a corporate objective of equal standing with the quality of our products and business success. A preventive health policy and improving safety at work are therefore key management duties. To achieve a further significant improvement in health and safety, the company has combined all measures in achieving the 'Zero Accidents' initiative," said Martin Brenner, ThyssenKrupp Ingeniería Chile's general manager.



Chilean service companies become world class

Sophistication in Mining Services

Rema Tip Top is a manufacturer of products for conveyor belt maintenance, wear protection and corrosion prevention. (Photo courtesy of REMA Tip Top).

In the last two decades, Chile has developed a cluster of service companies that are now leaders in the region. The huge quantities of mining investment have significantly increased demand for mining service and equipment suppliers in the country, and today's challenge is to meet this trend in order for Chile to reach even greater levels of technological sophistication and development.

"Chile has some great mines, especially the ones operated by Codelco and the multinational mining companies. Miners from all over the world routinely visit them. The operating standards for those mines are high and that allows Chile to remain competitive," said Ricardo Garib, general manager of Weir Minerals, who manufacture tools involved in extraction, from pumps and valves and siphons to tanks and other recipients for guarding and transporting the raw materials that are extracted.

The need for technical expertise in the service sector is such that mining companies themselves are playing a significant role in developing it. The project of the world-class supplier development program started by Codelco and BHP Billiton aims to develop 250 world-class suppliers based in Chile by 2020. The program calls for providers with development potential to solve those challenging issues that have been prioritized by the operational areas of the involved mining firms, which are currently lacking satisfactory solutions. Thus, the program seeks to create development opportunities for local businesses, encouraging them to compete globally. This agreement also represents a boost to the international projection of suppliers operating in the Chilean market.

"The objective is that the companies have world-class internal processes and in-

novation programs that can be used in the mining sites and exported to other parts of the world: this is unique. The project is going to take about two to three years and we are helping companies to build a sustainable mining practice. The first months that we spend in each company are to help understand the key drivers in the company and how it addresses the needs of the mining industry. We want to identify where the company can develop new solutions and how they can package it on a global scale," said Colin Becker, partner of PricewaterhouseCoopers, a global consultancy that takes part in the world-class suppliers project.

To date, BHP Billiton and Codelco have a total of more than 50 projects being executed by a similar number of suppliers, which, by solving specific challenges in the Chilean mining industry, advance in their path to world-class suppliers.

Automation and IT systems: the mines of the future

As a result of lower-grades and the increasing age of the pits, mining operations in Chile have much more volume to process than they ever did in the past. Consequently, the mines in Chile are bigger and bigger, and therefore require advanced technologies to coordinate operations.

Technology is key to the competitiveness of all service companies, whether they be international or Chilean. "Our advantages are a combination between state of the art technologies and specialized services; we are focused on instrumentation and measuring equipment for companies. We do it directly in Chile, where we have well capacitated personnel who we are constantly training. Endress+Hauser owns its own

R&D center dedicated to develop mining projects with new technologies or solutions," said Susana Torres, managing director of Endress+Hauser.

Micomo, which is a subsidiary of Codelco, developed advanced technologies in collaboration with the Japanese firm NTT, the second largest telecommunications company worldwide. "Today, due to the remoteness of the mining sites, long distance command, communication and information is crucial. In El Teniente, thanks to photonic fiber, we are able to do remote operations, as well as at the Andina division. We are also developing robotics and biotechnology and without a doubt we will be able to have a more sustainable, competitive, and lower cost mining through the incorporation of all these new factors," said Edgar Happke, general manager at Micomo.

Mine planning becomes increasingly more important in all aspects of work. "Mining is a very dynamic environment so companies need to be accurate to ensure that they achieve the mine plans," said Hans Schoch, general manager of Micromine, an Australian company that produces software for the mining industry and is expanding its operations in Latin America.

Micromine has created software to manage operating mines and mine production. "Our Pitram system records all mining activities from development to production and all the equipment that is being used. Customers do not need a control room to monitor where all of the equipment is and where it is operating. In the long-term, data is stored and customers can go back to analyze how long a process has taken, how crews perform, how equipment performs and they can evaluate the data to make



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more intelligent decisions. Safety is of paramount importance so we can see where people are at all times and what they are doing so any incidents can be recorded.”

Also, the technology related to exploration has improved to shorten the time for analysis of geological data. For example, Australia-based FEI Natural Resources, the world leader in electron optics and focused ion beam technologies, provides automated mineralogy solutions and SEM based technology that can identify minerals and rocks. “With FEI Natural Resources’ technology it is possible to achieve in an eight hour shift – as in the case of Codelco Andina - the same amount of work that 10 years ago would have taken months using the traditional techniques. Our company provides the hardware, software, training and support - this includes from the pre-installation evaluation of the site to the start-up of the laboratory,” said Patricio Jaime, FEI’s business development manager (natural resources) in South America.

Service companies need to be competitive in improving efficiencies in the mining process, from exploration, to evaluation, production and remediation. The world-class program promoted by Codelco and BHP Billiton encourages companies to

develop solutions. “In 2007, we surveyed mining directors in Chile and Peru to understand problems they were encountering at the production level. After the analysis, we were able to select 36 main issues, for which we came up with 12 solutions. For example, we have automated the truck system for fuel control. We are working with a German firm that specializes in the use of radar for collision avoidance systems on haul trucks. Currently, there are many systems. Some use infrared technology, but we use a more innovative technology that scans continuously operating vehicle’s movements,” said Claudio Soto, general manager of C2 Mining.

Technology related to automation is an important part of the development of new mines. “In the context of the shortage of skills in the mining industry, the fact that a company can carry out its operations with a reduced number of workers is a huge advantage. For example, ABB has worked with Antofagasta Minerals at Esperanza. It is one of the first mines in Chile to have its control centralized. In other mines, every area normally has a sort of localized control with workers that monitor incoming information and this requires a higher amount of workers,” said José Paiva, ABB’s country manager.

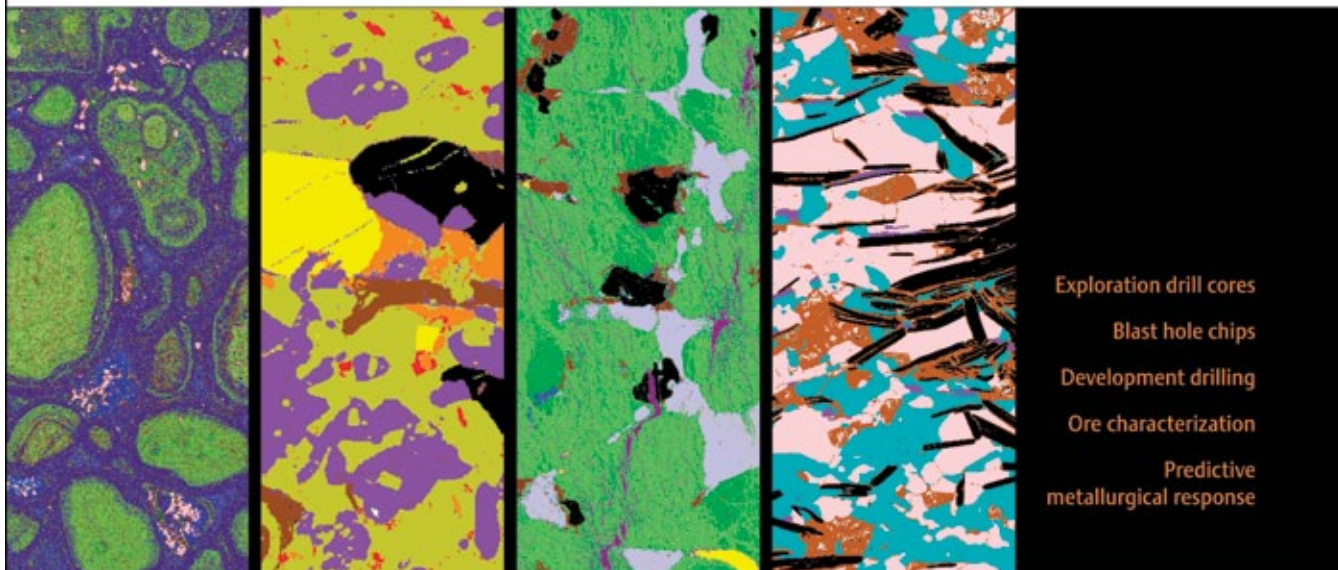
Endress+Hauser, an international company with more than 50 years of experience in process automation and instrumentation, has also developed its digital communication technology called Foundation Fieldbus, between teams that are currently on field and the centers that receive the information. “The competitive advantage of this technology is that it allows better control of the plant thanks to the available information, such as temperature, pressure, and incoming flow, all this without the need of transporting people on field, and so improving maintenance of the plants. With Memosen digital sensors, the levels of savings rise up to 30%, and they are used in mines such as Escondida,” said Susana Torres, managing director of Endress+Hauser.

Codelco’s Andina mine is an example of innovation and experimental application of new technologies. C2 Mining has worked on a pilot project in one of the plants: “We installed an automatic system that scans miners, checking with a sensor if they are wearing all their safety clothes at the entrance. Many companies work on new separated technological solutions for the mining industry, but we think it is important also trying to integrate them, to add value to our clients’ operations,” said Soto of C2 Mining.

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Another important innovation is virtualization, which is the creation of a virtual version of the mine's hardware system, to centralize administrative tasks of the mine and back-up the data. Andes IT is a young Chilean firm, which has focused its services on this niche market. "Andes IT offers the service of strengthening business processes through virtualization, seeking to consolidate the mines' infrastructure. We provide mechanisms and technology to make safer mining sites. Thus, if a site crashes by earthquake or a contingency issue, thanks to virtualization, there is an immediately available alternative with minimum down time of service. We work on contingency plans to lift the entire operation off of the mine," said Leonardo Garrido, Andes IT's CEO.

Associated with the same concept, Andes IT also deals with the issue of logical security, to protect company records. "It is increasingly more relevant for mining companies to avoid and prevent attacks that might remove sensitive information from their databases. We are improving Codelco's data management system, to strengthen their IT infrastructure. Andes IT also installed equipment at El Teniente for its IP network management," said Garrido.

Logistics companies are also becoming more sophisticated from a technological point of view, to comply with the mining industry's needs. "We are investing a lot of time, money and resources into the constant innovation of our logistics systems. We have recently launched a global IT platform, which is one of the most important pillars of Bertling's reputation and we believe that it will make a big difference. The system is constantly upgraded and allows easy communication between offices as they all use the same software, systems and reports. The amount of information that we can process, send and report to the client is incredible and we believe that we are one of the leaders in IT," said Alberto Morante, regional managing director of Bertling, a growing shipping and logistics company in Latin America who will be, among other projects, responsible for 8,000 trucks at Barrick's Pascua Lama.

"In our proposals we provide a detailed and tailor made execution plan for every project. Our studies involve local knowledge of where the activities will be conducted and using our knowledge of the shipping market we are able to work out the end-cost of a project. We have strategic alliances with different carriers to enable us to provide a strategic shipping plan that is low-cost with a quality service. It is vital to secure conti-



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nuity for a project, so we need to pre-plan and understand the different control mechanisms in a project like container planning. Bertling tries to put technical proposals in place that are consistent, current and that the client understands and is comfortable with. Our aim is to convey our experience in specific proposals for each project and to provide our clients with a competitive price. Loads that are abnormal or heavy are managed by transport engineers to create or design new tooling systems to optimize the logistics, which makes a big difference. The clients that we serve are confident that we are able to deliver," said Morante.

Due to the growth and amount of investment in the mining industry, mining producers are outsourcing all the maintenance services and this represents a significant business opportunity for the service sector. Service companies need to be able to integrate maintenance services and provide solutions, not just supplying equipment.

Drilling services

The Chilean exploration market is very large and the country is relatively mature. This situation differs from emerging countries such as Peru and Colombia. "Some companies did not do enough exploration in Chile in the past and are therefore catching up

now," said Raúl Dagnino, general manager of Terra Service, a Chilean drilling contractor with bases in Santiago and Copiapó.

Dagnino considers the dynamics of medium-sized companies to be very important: "A company like Yamana drills more holes than Codelco. Nonetheless, exploration is not at its ideal levels yet and only today mining houses are starting to spend the money they should be spending. Companies are stepping up their exploration investments. BHP has announced that it will spend US\$400 million in the next four years. In the early 2000s, the total budget for Chile was around US\$100 million per year. Now a single company will spend that amount, so exploration is picking up. Chile is awakening with regards to the exploration business. There are opportunities for high quality drilling companies because the market needs to develop to better serve its customers."

Laurie Cyr, general manager of Fordia, a Canadian company that manufactures and sells exploration drills and drilling equipment said, "The drilling business has grown much quicker in Chile than in other Latin American countries: in only two years, the number of core drills has gone from about 270 to 330. Fordia operates also in other countries in Latin America, such as Colom-

bia, Guyana and Peru, where our branches are all running at 100% capacity".

The fast growing field of mineral exploration in Chile by both big players and junior companies has created the need to rely on high quality drilling services and quicker delivery times.

"Against smaller competitors, our size allows us to meet orders faster. Probably 90% of our accessories are available the day they are ordered. Other accessories may take two to three weeks, and drilling equipment takes just two months. Against larger competitors, our advantage is that if a client has a problem with a product, I can call the person that made the part," said Cyr.

As in the case of engineering companies, the main manufacturers of drilling tools are present in Chile and the market is extremely competitive, despite the country's demand for drilling rigs being extremely high. Fernando Buttazzoni, vice president and general manager of Christensen, the largest drill company in Chile and the only one producing diamond bits in Chile, is a realist about the competitive situation. "Our competitors are the largest companies in the world, such as Fordia and Atlas Copco. Therefore, we must offer a first class product. Today we are exporting and working at full capacity. Our main destinations are Australia, Can-



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Fernando Buttazzoni, vice president and general manager, Christensen.

ada, Finland and Croatia. We have agreements with large industrial groups, which label our products, keeping our brand.”

“One of our advantages is being local, our customers don’t need to place an international order and wait for it. Moreover, we are very competitive at providing after sales services,” said Buttazzoni, whose company participated in the rescue of the 33 miners trapped in the depth of the San José mine in 2010.

Eugenio Fierro Ahumada, general manager of Mining Parts, a company that produces its own line of drilling equipment, also believes that post-sales services are

vital to be competitive. “We have a service unit to meet our clients’ needs on the ground but with one caveat: being able to exchange components quickly is fundamental to maintenance. In maintenance, to be successful, you have to standardize your equipment. Mining Parts teams always keep ready standardized components to be able to give a quick response in terms of spare parts. Any failure that stops a drilling machine is very expensive and companies cannot afford to wait while repairing a machine. In relation to this issue, Mining Parts promotes a component exchange campaign with our customers, promising that one of their machines with a failure will never be more than two hours without working,” said Fierro.

Another competitive advantage is the constant innovation in new technologies. Both Chilean companies and international ones develop new technologies to be more competitive. Mining Parts developed intelligent machines that calculate geological data automatically and incorporate safety elements in its drilling machines to minimize operational risks. Ingetrol, a manufacturer of drilling rigs, introduced computerized drilling equipment six years ago. “We want to input more technology into our machines to enable a more accurate and faster



Luis Silva Arrieta, President and CEO, and Marilú Málaga, vice president, Ingetrol.

transfer of information,” said Luis E. Silva Arrieta, President and CEO of Ingetrol.

Carlos Andrés, operation general manager of Atlas Copco, an equipment provider that covers many aspects of mining, said, “We are not just focused on the present; we have special engineering teams constantly working on the research and development of new products. Over the last few years, there has been exponential growth in the mining industry; it is only logical that we try to keep up with this growth. We work with the feedback we get from clients to improve our current products and make new ones to meet the needs of the market. We are

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Carlos Andres, operation general manager, Atlas Copco.

always a step ahead. On the world level, across the gamut of our product lines, we are considered leaders in innovation."

If quick delivery times and strong post-sale services are essential to be competitive, a growing range of Chinese products available on the market has meant that price has also become an important factor. Ingetrol specializes in portable drilling machines, with 400 machines in 40 countries around the world. "Ingetrol has strong competition from China, as their selling price is similar to our cost of production in Chile, so we had to re-engineer the company strategy. Since Chilean wages are higher than



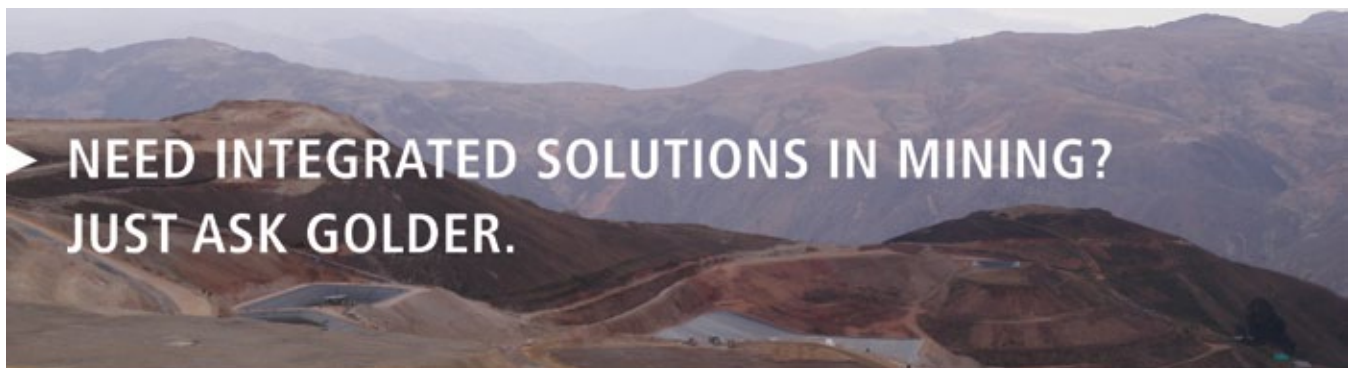
Ingetrol team working with the Explorer Jr. 36D in Panama. (Photo courtesy of Ingetrol).

those in China, Ingetrol has opened its largest manufacturing facility in Mexico, to produce high-quality products with lower costs, while using our engineering expertise from Chile," said Silva.

Engineering companies

The Chilean engineering sector is strongly positioned within the Americas to take advantage of new opportunities emerging in the region. Chilean engineers are widely recognized by leading global firms for their excellent technical skills and they are considered to be world leaders in engineering for mining.

"Here in Santiago you can find the largest companies in the world: international consulting and engineering firms such as SNC-Lavalin, AMEC, WorleyParsons, Bechtel, Jacobs, AMEC, Fluor, Hatch, ThyssenKrupp, who have important agreements with the large scale mining developers, such as Barrick, Kinross, Codelco, etc. Santiago is a center of operations, delivering projects to Peru, Colombia, Africa, Australia, and other worldwide locations. In 2010 SNC-Lavalin assigned the Centre of Copper Excellence to its office in Santiago, so all copper projects around the world are reviewed in Chile. We will provide techni-



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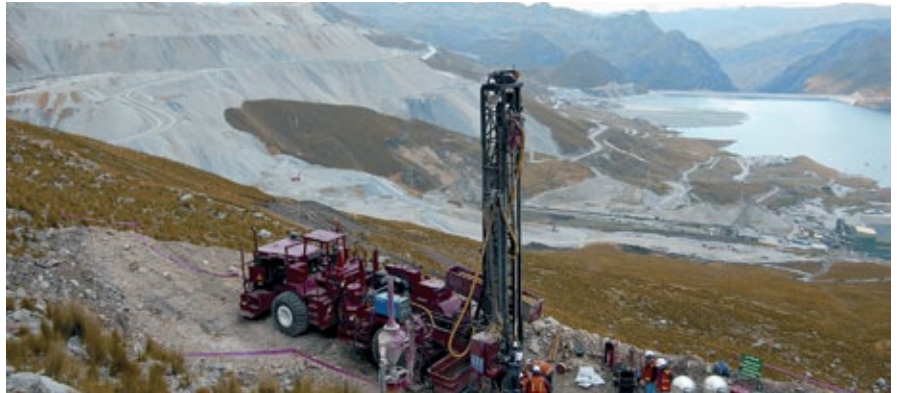
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Joaquín Cano, vice president and general manager, SNC-Lavalin.



Golder Associates is one of the main mining consultancy companies in Chile and other Latin American countries. (Photo: Antamina East Waste Dump expansion, Peru; courtesy of Golder).

cal support and guidance from this office. All copper projects need to report to our office," said Joaquín Cano, SNC-Lavalin's vice president and general manager.

SNC-Lavalin's Centre of Excellence for Copper in Santiago has provided complete lifecycle implementation services for a variety of copper projects. Project teams have carried out basic and detailed engineering for many copper processing plants and have gained unique experience in designing for remote and harsh conditions ranging from high altitude projects in the Andes to projects in central Africa and tropical Australia. "We have created an innovation and devel-

opment division in Chile to support clients in both new and existing projects. As an engineering company, we saw there was a service missing in the industry, so now we work together to find new ways to do things to improve technology and improve existing processes and equipment," said Cano of SNC Lavalin.

"The presence of international service firms makes this market very attractive for large-scale investments, as Chile can offer the expensive infrastructure that this type of operations needs and world-class services. Around US\$120 billion will be invested in Latin America over the next few years. This

amount of investment represents an opportunity that will facilitate collaboration and networking among companies," says Andrés Poch, President of the Association of Consulting Engineers of Chile.

Chilean companies have proved their capacity to expand to other countries, as they already provide their services all through Latin America. "There are even those who are completely dedicated to exporting," said Poch, whose association briefs engineering companies on strategies and know how to export their expertise.

"Golder Associates' team is operating on a more regional level: we have offices in

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Delkor designs and manufactures mineral processing equipment, such as floatation cells. (Photo courtesy of Delkor).



Luis Garrido, general manager, AMEC Chile.

Peru, Argentina, Chile, Panama and Brazil. We work together with our offices in Australia, Canada and the United States. Since Golder Associates started in Latin America in 1996, people from all over South America have joined our team. Our operations in South America are becoming the strength of our company in the mining industry on a global level. The image that innovation and industrial design comes from abroad is one we always wanted to change. We have much to offer to the world, and people have started noticing this," said María Eugenia Parot, Golder Associates' general manager.

Delkor, a global company specializing

in the design, manufacture and supply of mineral processing and separation equipment are also strengthening their presence throughout the Americas, after five very successful years in Chile, Mexico, Argentina and Peru. Innovation is key to its strategy: "Delkor is a company with a strong focus on its clients, their needs on modern mining process solutions, through innovative design and the development of an active customer service. In our company, we work with specialists, who know about processes and first category engineering. Our goal is to satisfy our customers through the technological development, service, and closeness to the cli-

ent," said Rodrigo Herrera, managing director for Delkor.

The presence of huge copper mines is an opportunity for engineering companies to design innovative solutions that streamline the process. "JRI has accumulated expertise in all specialties of the mining industry from its experience on the field. For example, in 2009 and 2010, when the copper price decreased, BHP Billiton's Escondida mine needed to increase its production, as the copper content of the ore was decreasing. So they needed to grind more, and increase the size of the flotation plants just to maintain the same level of

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copper production. They needed a concentrator expansion of 25% to 30% in two of the plants: Laguna Seca and Los Colorados. We accomplished that," said Ricardo Nicolau, managing director of JRI, a Chilean engineering company that has used its Chilean expertise to provide work in Peru, Bosnia and the Democratic Republic of Congo, among others.

Alquimia Conceptos, a Chilean consultancy, has also developed a specific expertise on mining and metallurgical processes working on the field. "We have worked with nearly all key mining companies in Chile. We have defined the processes of Esperanza and Mina Ministro Hales for Codelco. As a consulting company, Alquimia has very few competitors as we are very specialized. We work with engineering companies with many more employees than we have, but they do not have the expertise we offer in mining process consultancy," said Leticia Conca Benito, general manager of Alquimia Conceptos S.A.

With the current shortage of human resources in the industry, having experienced engineers is a major competitive advantage for engineering firms.

"Our teams combine local professionals with foreign experts. As the size of the projects increases, there are fewer and fewer people with the know-how to make the projects successful. The excellence of our teams makes us stand out. We give a level of quality to clients, so that they come to us early in the process of planning. We work with clients at all stages of projects, from the original ideas to the implementation and completion of big projects," said Luis Garrido, AMEC Chile's general manager.

"Good engineering is the way to avoid accidents and assures that the environmental aspects are incorporated during the design phase to prevent issues from both surface and subsurface that would be a liability for the community for long time," said Dave Lawson, global president minerals and metals of Ausenco, a large engineering and project management company.

The economic crisis in 2008 forced engineering firms to diversify their activities. Leading engineering companies with operations in Chile are developing capacity in energy and infrastructure projects.

Energy is a relatively new business line for Ausenco, yet has enabled the company to enter a new and growing market in providing engineering solutions for the power industry. "We provide engineering solutions for power plants, whether it is for a gas plant, a diesel plant or a coal plant. Ausenco has been working on power plants in Canada, USA and other parts of the world, but not here in South America yet. We are looking for opportunities to develop Ausenco Energy in South America," said Dave Lawson, Ausenco's President.

Twenty years ago, when global companies arrived in Chile they imported all the knowledge related to mining from developed countries. Today Chile is exporting mining engineering services all over the world. This represents a great opportunity to increase the country's engineering expertise in other sectors. The goal is to import knowledge, develop local know-how and then export it to the rest of Latin America.

Equipment providers

The implementation of advanced technology and integrated solutions has the potential to optimize overall mine productivity and further reduce equipment costs. These capabilities will be a key component for equipment providers to be competitive. "Weir is the leader in manufacturing all the tools that are involved in extraction. To provide integrated solutions to its clients, Weir invests a lot in technology," said Ricardo Garib, South American regional director of Weir Minerals, which has doubled its business between 2007 and 2010 and plans to double its size again within the next five years.




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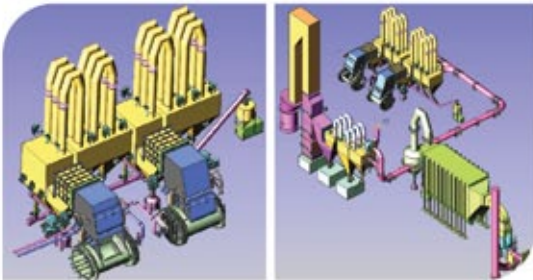
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The Siemens-manufactured ore crusher at Codelco-Norte's Radomiro Tomic mine. (Photo courtesy of Siemens).

In addition to providing a range of equipment as complete as possible, international players have also understood the importance of customizing their solutions to the clients' needs. "For the increasing complexity of current mining sites, an understanding of the processes is required and this involves being a partner participating along with the customer," said Carlos Andrés, operations general manager of Atlas Copco.

Finning, Caterpillar equipment's distributor in Chile, is focused on supporting the vast range of products they distribute. "Caterpillar makes the equipment; Finning delivers the equipment to clients and makes sure it keeps working for them. In South America, we have more than 6500 employees, and about 80% of our employees are mechanics and technicians that work on equipment for clients," said Juan Antonio Winter, vice president of mining of Finning South America, a company present in other South American countries such as Argentina, Bolivia and Uruguay.

Maintenance services have become an important part of business for service providers, accounting for 40% to 80% of their revenues. "Maintenance of mining machines and systems is a sizable cost factor for mining producers and therefore service companies such as Siemens need to tailor a maintenance strategy for each mining company and for the individual mining processes." said Edwin Chávez, CEO of Siemens Chile, which has four maintenance contracts with Minera los Pelambres, Minera Gaby, Radomiro Tomic Húmedo and Radomiro Tomuc Sulfuros.

"Of the 800 people working in Metso, 600 are earmarked for services that meet the requirements in different parts of Chile. Moreover, Metso's services aim to provide comprehensive support to our customers' business continuity by providing technical support and spare parts. To do this, Metso ensures availability of spare parts on-site to improve customer responsiveness before any accident occurs and incorporates specialized technical support staff to improve the existing processes," said Macarena Vallejo, marketing and communication manager at Metso Mining and Construction.

Finning confirms the increased importance of post sales services. "The way mining companies do sales in Chile is that they buy equipment, and along with the equipment a contract for maintenance. We have pretty much perfected the maintenance aspect of these sales and set a standard for the industry. We are contracting 1,000 technicians a year, training them and putting them to work on the maintenance of Caterpillar equipment," said Juan Antonio Winter of Finning, which grew its Chilean business by 30% in 2011.

The reason for the growing importance of maintenance services is that, because of staff shortages and the complexity of mining operations in Chile, manufacturing companies outsource maintenance systems. Services companies need to take this into account to be



Michael Labbé, president of operations, Rema Tip Top.

successful. “The growth strategy for Rema Tip Top is to provide a fully integrated maintenance service on the top of the material handling and processing industry. Our clients are focused on producing copper, and we help them maintaining their systems,” said Michael Labbé, president of operations at Rema Tip Top, a manufacturer of conveyor belt maintenance, wears protection and corrosion prevention. The German firm, which has been supplying the Latin American markets for more than 40 years, expects to grow about 25% to 50% per annum for the next three years, thanks to the growth of their maintenance services.

The demand for services in Chile requires scale. “With Collahuasi mine, we have 400 workers and we do all the maintenance on the equipment they have. We take the risks, we are responsible for the people and the tools, and they pay us by the hour. Other companies have in-company maintenance policies. We are flexible enough to work with clients and do whatever makes them comfortable,” said Jeff Dawes, Komatsu’s President.

From Chile to the world

In Chile the demand for new technologies is covered by foreign companies importing and distributing their advanced products and solutions. At the same time, the industry needs more products oriented to the special features of each phase of operation. Tailoring products according to the clients’ needs is a way for Chilean companies to set themselves apart from international competitors.

“There was a need for the design and manufacture of more equipments in Chile, to be able to satisfy the local requirements of the mining industry. Three years ago, Delkor developed a Center of Excellence for Thickeners in Chile, so we can develop the design locally here in Chile and position ourselves in the industry, being competitive for large-scale projects,” said Rodrigo



Jeff Dawes, President, Komatsu.

Herrera, managing director for Delkor, a company that sells horizontal belt filter and thickeners, among other products in both South and North America.

Delkor, contrary to the more traditional route of established mining companies moving from developed mining hubs such as Canada into the South American region, used the advantages of the Chilean market to establish their first footprint in the Americas. “Delkor decided start its American operations from Chile because of Chile’s mining tradition. The other advantage was that the market in the region was very open to development; this allowed us to take the



Claudio Dodds Figueroa, business development manager, Coprim.

first step. Later on we had the possibility of accessing the North American market, and managed to establish an office in Vancouver,” said Herrera.

Patricio Lagos, general manager of IDT Power Electronics, which is one of the few companies in South America that produces high voltage rectifiers to produce cathodes in copper mining, agreed on the fact that design is an important aspect to adapt to the local market needs. “We deepened the relations with our clients to better understand their requirements and design our rectifiers accordingly. Our design focuses on efficiency and reliability. We have patented at least

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nine of our technologies and are ready to export them.”

Chilean companies that have developed a specific expertise or technology have started to expand abroad, providing services and equipment to other countries, especially in Latin America but also all over the world. For example, Chilean company Coprim, which provides engineering and supplies smelting and refining equipment in Latin America, is also present in Europe, Africa and is expanding its services in Eastern Europe. “Since Coprim began, it has participated in the development of all Chilean casting plants. This has allowed us to evolve with our clients and continue to make technological advances, and in turn, this has facilitated increased development for our clients. Now, major companies have come to depend on us. Since we are real specialists in certain areas, Coprim has managed to reach a very good level of productivity; this means that the prices we offer are very competitive in Chile and other countries around the world,” said Claudio Dodds, Coprim’s general manager.

Coprim is a prime example of how Chilean companies are embracing the benefits of globalization, not merely in the markets it opens but also in terms of the expertise and technology it gives them access to. “Over the years, we have developed a lot of techniques related to engineering; we have worked with specialists from all over the world and made our own breakthroughs here in Chile,” Dodds said. “More importantly, we have learned a lot about issues that are greater than problems of engineering. We have worked with clients from all over the world, and we have learned that for all of our clients, be they Chilean, Peruvian, Canadian or from any other country, there



Rodrigo Undurraga, general manager, Prodinsa.

are issues that have to be dealt with on a case by case basis.”

Küpfér, an industrial equipment provider, is another positive example. “Until 2010, Küpfér was only in Chile. Last year, we opened our branch in Lima, Peru. For the next 5 years, our plan is to develop our mining business in the rest of Latin America, as we see many opportunities. In the near future we will move forward, perhaps starting with projects in Colombia and Ecuador,” said Pedro Bartolomé Cecchi, Küpfér’s general manager.

Expertise developed on the field appears to be a competitive advantage for Chilean companies. Prodinsa, which is the only cable manufacturer in Chile, was selected to participate to the world-class suppliers program. “BHP Billiton, with whom we were already working since many years, has listed the problems they have, including producing cameras to see when a steel cable is about to break, and Prodinsa is going to implement this solution,” said Rodrigo Undurraga, general manager of Prodinsa, which is expanding its business internationally.

Conclusion

A Bright Mining Future

Since the 1990s, Chile has been one of the fastest growing economies in the world and according to the World Bank it is the best country in Latin America to do business in. The Chilean government strongly supports foreign investment in the mining sector and has modified its mining industry laws and regulations to create a favorable investing environment for foreigners. This context has attracted, in addition to mining investment, the largest international suppliers of business services and equipment. The highly competitive market developed over the past 20 years has led to the sophistication of the service sector, through new technologies, integrated suites of equipment and more sophisticated assistance and maintenance services. Moreover, the world-class producer program promoted by BHP Billiton and Codelco encourages Chilean companies to find innovative technical solutions to increase safety and efficiency throughout the production process.

Overall, Chile has a positive combination of substantial mineral reserves and a favorable business environment. However, the sector will need to overcome the challenge on the water shortage in northern Chile, where the greater part of mining operations take place and the shortage of energy and infrastructure, as well as a deficit of skilled professionals needed to support the industry’s development. Despite this, efforts to both expand existing copper operations and establish new ones bode well for the continual ranking of Chile as the world’s largest copper producer. Combined with the growing focus on other mineral extraction, especially in gold, silver and molybdenum, Chile’s domestic mining future looks assured.

Yet Chile is also looking outside its borders. The economy, with a growth rate of 6%, already relies on its export of goods, yet services are set to play an increasingly important role. The mining community, with its presence in Chile one of the most established in Latin America, has the necessary expertise, particularly in engineering, equipment and innovative technologies, to take advantage of booming industries in its neighbouring countries. With new regulations from the government ensuring that inward investment continues unabated, an increasing outward flow of Chilean expertise will further enhance the nation’s standing as South America’s mining hub.



Planetary strander for production of shovel rope strands. (Photo courtesy of Prodinsa).



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