

# Chile Mining 2017

PRF-RFION

#### Table of Contents

- 3. Copper: Chile's Past and Future
- Preparing for an Upswing
  Innovation and the Future of
- Mining 11. Production Map & Directory

### Dear Readers,

Just in time for the expected rise in price and demand for copper, Global Business Reports has returned to Santiago to update our global readership on the status of the world's leading copper exporter—Chile represented 26.9% global copper production in 2016. The Atacama Desert, which lies in the north of the country, harbors one-third of the planet's copper reserves and analysts are in accord that Chile will remain a dominant mining leader, supported by the production of other commodities, such as gold, molybdenum, lithium, and more.

After many difficult years for the Chilean mining community, the country still has a lot to boast. Latin America's sixth largest economy is learning to be more cost-efficient, energy conscious, and community-oriented to ensure that Chile maintains mining as an integral piece of its GDP. Not only has the government's Fondos de Inversiones Estrategicas launched a multi-million dollar program for filling in the gaps prohibiting efficiency—increasing tailings monitoring and efficiency, developing local providers, and increasing transparency via an environmental measurement center, to name a few of its aims, but new regulations are also expected to further normalize processes and ensure that socially and environmentally sustainable projects come out on top.

Having spoken with many EPCMs within Chile, we can say with confidence that mining companies are already requesting work, a positive sign for an uptake in movement. For example, CODELCO is expanding and taking its Chuquicamata mine underground, and Teck Resources and Goldcorp are uniting two mines into one large project called NuevaUnion. Meanwhile, however, some of the major multinational mining companies are struggling to increase production due to labor conflicts and water scarcity, leaving investors wondering if Chile will be able to keep up with copper demand and with its rapidly growing neighbor, Peru.

In order to maintain its leading position Chile will need to hold on to its perception of being an open economy that welcomes investment. In addition to minimizing uncertainty in the midst of reforms, the public sector needs to follow through with its infrastructural promises of connecting the northern and central transmission lines, as well as ensuring its commitment to diversifying the energy mix with greater reliance on renewable energy.

GBR's research team is stationed in Chile for three months to conduct over 100 interviews with Chile's decision makers across the mining value chain, from government officials and the major mining multinationals to the regional service providers and their local affiliates. Our reports create a holistic view of Chile's current business environment, with insights on the most promising projects and the most pertinent new-market entrants.

We hope you enjoy this sneak peek of our discoveries thus far and we would like to thank all of our interviewees who have helped make our initial exploration such a success. Our final CHILEMIN Mining Investment Guide will be launched in March 2018 at the PDAC conference in Toronto, and will be the official investment guide for Chile's EXPOMIN conference, so stay tuned!

Meredith Veit & Imara Salas, Project Directors



2017 Pre-release

GBR GLOBAL BUSINESS REPORTS

This research has been conducted by Meredith Veit, Imara Salas and Kevin Norchi.

If you would you or your company would like to be part of the final report on Chile, please contact Imara Salas at **isalas@gbreports.com** 

Edited by Mungo Smith Graphic design by Özgür Ergüney Cover Image: The Escondida mine, the world's largest copper producer located in Northern Chile. Courtesy of BHP Billiton.

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Codelco's Chuquicamata Mine. Photo courtesy of Liebherr.

It is no secret that the global downturn in commodity prices has left mining jurisdictions across the world reeling since 2013. Chile, whose mining sector comprised 20% of its total GDP as recently as a decade ago, is no exception. As a country whose economy has historically depended on mining and whose national budget is pegged to the price of copper, Chile serves as a micro representation of the mining industry at large. From 2015 to 2016, the world's top copper producer fell from 11th to 39th in the Fraser Institute's Survey of Mining Companies, the result of which, in this case, correlates directly with investment dollars. According to Sergio Hernández Núñez, executive vice president of the Chilean Copper Commission (COCHILCO): "Since 2013, the portfolio of mining investment projects in Chile has declined significantly, from approximately \$110 billion to \$50 billion."

The purpose of this editorial, however, is not to examine the flotsam of a shipwrecked mining economy. Rather, 2017 is quite an exciting time for the Chilean mining industry. Not only does Chile still produce 30% of the world's copper — Chile produced 5.55 million tonnes in 2016, representing a year-to-year decrease of only 4%, according to COCHILCO — but it is also essential to recognize that \$50 billion of investment is no paltry sum. Chile's total copper exports in 2016 accounted for \$26 billion in revenue, "Chile is the biggest copper producer in the world. The country has developed unique technology, we have great professionals, and our institutions have 200 years of tradition and stability. Furthermore, Chile has a great deal of respect for international contracts, and investors can have legal certainty here."

Sergio Hernández Núñez, Executive Vice President, COCHILCO



#### Copper concentrate production forecast

Increased mineral processing



Source: Consejo Minero

3

#### **PRE-RELEASE** CHILE MINING 2017

matching 2009's copper export revenue, which was the low point before the most recent mining boom. If history repeats itself, then the optimism stemming from an expectedly sustainable rise in the price of copper and an imminent influx of foreign investment is warranted. "In my opinion, the price of copper has reached a floor," said Maritza Araneda, KPMG Chile's mining manager and resident copper expert. "By the end of 2017, prices should settle at \$2.65/lb or \$2.70/lb. A more sustained increase is likely to be seen in 2018, with further upside in 2019."

Fortunately for Chilean copper producers, global demand for copper has remained relatively steady. Anticipated infrastructure investments from the United States and China, as well as the looming transition from fossil fuels to electric batteries in the automotive industry, bode well for copper's inherent application value. The Financial Times reports that Chinese consumption of refined copper is expected to grow at 2% per year over next five years, and according to the Observatory of Economic Complexity, \$13 billion worth of Chilean copper exports were destined for China in 2015. "China consumes approximately 45% of the world's copper," Araneda continued. "At the end of the day, whatever happens in China will heavily influence the price."

"Chile is very important, as it is a large mining country and has a good exposure to copper, lithium, and iron ore. We would like to focus our business on *Chile and Peru to get more commodity* diversity."

Dale Clayton, Mining Division Director, Liebherr

#### **MAJOR MINES: SURVIVAL AND GROWTH**

For many copper producers in Chile, production continued at a fairly consistent rate despite a relative lack of return for their product. BHP Billiton's Escondida mine, the top-producing copper mine in the world, still produced over 1 million tonnes of copper in 2016, representing a modest 6.8% decrease in production from 2012. Anglo American and Glencore's Collahuasi mine, Chile's second-most productive copper mine in 2016, produced 506,000 tonnes, representing an 11.2% increase from the previous year. The state-owned National Copper Corporation (CODELCO)'s top-producing mine, El Teniente, has increased production every year since 2011. CODELCO's total copper production in 2016 amounted to

over 1.7 million tonnes, representing 31% of Chile's total production. BHP Billiton produced Chile's second-largest amount of copper in 2016 at 1.2 million tonnes. Mine production is volatile regardless of the state of the industry, but Chile's sustained level of production indicates an absence of any long-term economic health concerns.

Despite the current price of copper, CODEL-CO appears to have its sights set on the future, investing in projects that aim to extend the company's current mine lives. In fact, in 2016, CODELCO allocated over \$2.7 billion toward development projects as part of an \$18 billion investment plan that will last through 2020. The company's largest development project is at the Chuquica-

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mata mine, where it is developing an underground mine structure that is projected to add 40 years to Chuquicamata's current mine life. The underground mine is expected to be in production in 2019. El Teniente, already the world's largest underground copper mine, is also a recipient of the investment funding, as CODELCO is adding a seventh level to it that is projected to add 50 years to its mine life. Also in the El Teniente division, CODELCO implemented the Dacita and Diablo Regimiento projects, which are expected to generate a respective 490,000 tonnes of refined copper over twelve years and 126,000 tonnes of refined copper over eight years.

The decline in commodity prices, however, did not come without some detrimental effects. CODELCO's \$18 billon plan is a toned down version of its original \$25 billion plan. Despite a \$600 million investment from the government earlier in 2016, CODELCO has suspended its \$5.4 billion Radomiro Tomic sulphide project until 2024, and the deadline to expand El Teniente was pushed from 2020 to 2023.

Even more concerning for the country, CODELCO laid off over 4,300 employees in 2015, which created a ripple effect throughout the industry. "Mining in Chile has lost about 56,000 jobs, and two-thirds of that corresponds to mining providers," stated Pascual Veiga López, president of APRIMIN, an organization that represents and promotes the development of mining suppliers. "We are not currently seeing the salaries, bonuses, and employment numbers we have seen in the past."

Despite their decrease in manpower, CODELCO's production from 2015 to 2016 only decreased by a proportionately negligible 3.4%, which is emblematic of the rest of the industry in Chile. This is a direct result of increased operational efficiencies and investments in automation. "If you compare Chilean mining production in 2013 and 2016, however, you will only notice a small variation," continued Veiga. "Chile is obtaining good numbers but with 56,000 fewer workers, so that tells you that we are starting to overcome the challenge of maximizing productivity."

Nevertheless, as the market recovers, many miners may once again find work. Kinross, for example, is still carrying out aggressive exploration plans despite a temporary hold



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5

Commodity Production										
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Copper (tonnes)	5,557,000	5,327,600	5,394,400	5,418,900	5,262,800	5,433,900	5,776,000	5,761,100	5,772,100	5,552,600
Gold (Kg)	41,527	39,162	40,834	38,417	43,927	48,649	48,565	46,751	44,010	43,275
Silver (Kg)	1,936,465	1,405,020	1,301,018	1,276,242	1,268,717	1,151,202	1,217,780	1,596,852	1,547,158	1,494,707
Molybdenum (tonnes)	44,912	33,687	34,925	37,186	40,889	35,090	38,715	48,770	52,579	55,647

Source: COCHILCO

on gold production. "At the La Coipa mine, we continue to look for ways to restart the mine," explained Jose Tomás Letelier, vice president of external affairs at Kinross Chile. "We believe that the assets that we have in Chile have good potential and we would like to develop them further."

Production has not been suspended at BHP Billiton's Cerro Colorado mine, which the company has been negotiating to sell since April 2017. Having produced 74,000 tonnes of copper in 2016, the sale is expected to command \$800 million. Teck, HudBay Minerals, and Lundin Mining, which operates the Candelaria mine in northern Chile, have all been speculated as potential buyers.

#### **CHILE'S NEXT TOP MINE**

In addition to sustained production, Chile's development projects bode well for the well-being of the country's mining industry. In 2015, Teck and Goldcorp announced a 50/50 joint venture to consolidate their Relincho and El Morro projects into a single development project, NuevaUnion, which could become one of the largest mines in the world. The \$3.5 billion coper-gold-molybdenum project could save the companies a combined total of \$4.9 billion, as the Relincho project and El Morro project were expected to cost \$4.5



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billion and \$3.9 billion, respectively. The companies expect to have a pre-feasibility completed by the end of 2017.

Teck is also investing in its Quebrada Blanca mine, implementing a development project that aims to extend the life of the mine by 30 years. Also, while the mine has produced fewer than 50,000 mt/y of copper in each of the past three years, Quebrada Blanca Phase 2 is expected to extend the mine's production capacity by 240,000 mt/y of copper and 6,000 mt/y of molybdenum, putting the mine's production total nearly on par with Chuquicamata.

In 2015, BHP Billiton began a development project focusing on expanding the life of its Spence mine by 50 years. The feasibility study process began at the end of 2015, but the company has yet to decide whether to move forward with its \$2.2 billion of required investment. Spence has produced an average 173,000 mt/y of copper over the past three years.

In addition to its efforts at NuevaUnion, Goldcorp has also entered into a 50/50 partnership with Barrick Gold to develop the Cerro Casale project. Previously a 75/25 joint venture that featured Barrick as the majority partner and Kinross as the minority partner, Cerro Casale is known to be one of the world's largest undeveloped gold deposits. Like Goldcorp, this is not Barrick's only joint venture in Chile, as the company also owns part of the Zaldívar mine in a 50/50 partnership with Antofagasta Minerals. Large companies entering joint ventures as a means to hedge their bets may be a continuing trend as the market remains in a state of recovery.

#### INDEED, CHILE DOES HAVE OTHER METALS

Aside from copper, Chile is also the world's 14th largest gold producer, 4th largest silver producer, and 2nd largest molybdenum producer. Chile's gold and silver reserves comprise 7% and 14%, respectively, of the world's total reserves. Chile also accounted for 23% of the world's molybdenum production in 2016. Notable gold producers in Chile include Antofagasta Minerals' Los Pelambres mine, KGHM's Sierra Gorda mine, and Yamana Gold's El Peñón and Minera Florida mines.

Chile is also one of the world's largest lithium sources and, though Chile's lithium market is considerably less mature than its primary commodities of interest, it has not gone unnoticed. BYD, a Chinese electric vehicle company, has expressed interest in investing in Chile's lithium supply. The Salar de Atacama region holds 27% of the world's lithium reserves, and Sociedad Química y Minera (SQM)'s Salar de Atacama mine is the world's largest lithium brine mine. Additionally, Lithium Power International and Li3 Energy are currently developing their Maricunga project, the country's largest pre-production lithium project, which is projected to be in production by 2020. Codelco has also expressed an interest in lithium by establishing a lithium-focused subsidiary, Salar de Maricunga S.A., in April 2017.

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## **Preparing for an Upswing**



"The demand in new equipment dropped about 10%, and it was challenging to reorganize costs throughout the company. However, this brought on a surge of innovation to help our customers reduce the total cost of operations. We are at a point now where we have the lowest cost per production unit on the market."

Pedro Damjanic, Senior VP of Mining, Finning



"One of our divisions, Dyno Consult, specializes in software and terrain analysis. We have technicians who travel to Chile to help us decide where exactly to use certain explosives. Our engineers are constantly training to use our products and software and determining how to best use the data we have."

George Cariz, General Manager, Dyno Nobel



"During the last two years, we were involved in several mine closure projects, but we are starting to receive more due diligence requests for earlystage operating projects and pre-existing mines. I believe we will face an increase in activity in the coming years."

Esteban Hormazabal, General Manager, SRK Consulting



"We have been focusing on the reduction of water consumption, remote operations, routing, and drilling in deep wells. Water, in particular, is becoming a scarcer resource every day, which is why it is crucial for us to have water recycling and treatment systems."

Juan Uberuaga Rivas, General Manager, Foraco



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# Innovation and the Future of Mining

Chile as a hotbed for technological development

If a silver lining could be drawn from the downturn in the price of copper, it is that Chile has essentially been forced into becoming a global nucleus for technological innovation and engineering expertise. As mining companies focus on cutting costs while maintaining their levels of production, engineers have been tasked with developing efficiencies and fabricating creative solutions. While this is the case in mining jurisdictions around the world, Chilean mining engineers have a particularly high reputation and are considered on par with those in Canada and Australia. "The Chilean engineer is well recognized around the world in the mining industry," explained Juan Pablo González Toledo, president of the Institute of Mining Engineers. "In general, the perception of Chilean engineers is very strong in mining and in other industries."

Chile's mining expertise and the industry's call for creating efficiencies have coalesced into a perfect storm of innovation. There is a general consensus around the mining industry that autonomous mining is the most exciting of these innovations due to its positive financial, environmental, and security implications. "One of the positive things about automation is that it is steady, which reduces variability and saves millions of dollars," said Felipe Cabrera, general manager of Emerson Automation Solutions. "Automation also greatly reduces the risk of people working in the mines being injured."

CODELCO's Gabriela Mistral mine is thus far Chile's most advanced mine in terms of operating autonomously. While mining companies generally appear to be quite receptive to the idea of automated operations, labor unions are much more skeptical. While it is reasonable to conclude that autonomous mining will replace human workers with machines, it does not necessarily imply fewer jobs available in mining. On the contrary, many believe the new technology will, in fact, elicit new employment opportunities. As Pedro Damjanic, senior vice president of mining at Finning Chile, stated: "Some people are scared that autonomous mining will result in a loss of jobs, but what they forget is that it creates opportunities to open many other mines that are otherwise too expensive to pursue."

Even if autonomous mining does create new job opportunities, many of the workers who are replaced may not be qualified for these new positions. According to Felipe Cabrera: "The challenge when removing people from risky positions is that, while we would like to place them in front of a control console where they can oversee the operation and come up with ways to optimize production, those positions require a whole different set of skills than what they have."

Process mechanization also plays a major role in increasing safety measures. Mining inherently involves a considerable deal of risk, and limiting human involvement in the more dangerous aspects of the mining process can mitigate this concern. "In Chile, the explosive loading process is not yet mechanized," said Marcelo Anabalon, general manager of Normet. "We are working with Chilean explosives company Enaex to further develop this technology, and we have sold them the first machine."

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"We have developed a road map to 2030 that addresses technological development and mining suppliers, greater social inclusion, and better environmental standards."

Juan Francisco Bustos Donoso, Head of Mining Investment Office, Chilean Ministry of Mining



Autonomous mining addresses the fact that thousands of workers can be living on a mine site at one time, which is costly in terms of both accommodations and employee morale. Remote operations is an increasing popular technological focal point, as it would allow employees to telecommute to a mine from a control center at the company's headquarters. ABB, for example, has already developed this technology and uses it to monitor their operations at their clients' mine sites, as opposed to sending their employees back and forth. According to Jorge Abraham Canales, ABB's industry lead for mining: "The opportunity to work on mines remotely is going to be the next big demand trend, and that is something ABB is pushing for."

The use of data has also become more prevalent in the mining industry. Each rock in a mine and each machine part have various data points associated with them, resulting in a nearly incalculable quantity



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#### "Automation in mining is very realistic and can be implemented in almost every possible mining process. Remote

operations are also very important because it allows employees to access equipment in a secure and comfortable way."

Pascual Veiga López, President, APRIMIN



of data at any given mine site. Some equipment companies have begun to leverage Big Data analytics to develop predictive capabilities that limit operational downtime, which could potentially cost a mining company thousands of dollars for every hour a machine is down. "Regular maintenance is important, but it can be costly if parts are replaced or repaired at the wrong time," said Marcelo Celis, general manager of Bosch Rexroth. "Production downtimes can have a devastating impact, which quickly affects many other parts of the value chain."

One of the most pressing issues in Chile's mining industry is water scarcity. While Chile evidently has plenty of access to water on its coast, transporting water to high-altitude mines has proven very costly in terms of the amount of energy it requires. Underground water is also becoming increasingly scarce and energy-consuming to extract, driving both producers and service providers to devise new water recycling tactics. "Kinross has taken measures to be more efficient with water usage and is using less water to produce the same amount of ore," said Jose Tomás Letelier. "We recycle a high percentage of the water we use, we have improved our piping, and we have lowered evaporation rates, which is a common issue at such high altitudes."

Chile is also known to have high energy costs, and while the government has made an effort to curtail prices, the responsibility to innovate solutions that circumvent these costs has been placed primarily on the shoulders of engineering companies. Many companies are pushing for a transition toward renewable energy by setting specific thresholds of renewable energy use. "15 to 20% is a good number to start with, but we are aiming to increase to a higher percentage than that," said Juan Carlos Sarquis, general manager of SNC-Lavalin's mining and metallurgy division. "We are moving very fast towards these types of initiatives because we understand that mining needs to be more sustainable."

As the state of the mining industry has repeatedly flashed its hazard lights over the past several years, mining companies have no choice but to consider the future. Whether it is a response to companies cutting costs or environmental challenges, Chile and its talented pool of engineers are prepared to lead the charge toward more efficient mining practices as commodity markets are poised to rebound. "The only way to cut costs for our clients is by innovating," explained Micaela Barrientos, mining and infrastructure manager of Arcadis. "We look at what the industry has published to make a list of potential studies to further explore, and we look for supplies or technologies that may help specific requirements for specific clients."

10

## **Production Map & Directory**



Taraapacá Region	Products	Company
Cerro Colorado	С	BHP Billiton
Collahuasi	СМ	Anglo American/Glencore
Quebrada Blanca	С	Teck Resources
Antofagasta Region	Products	Company
Antucoya	С	Antofagasta Minerals
El Abra	С	Freeport McMoRan/CODELCO
Radomiro Tomic	С	CODELCO
Chuquicamata	СМ	CODELCO
Ministro Hales	С	CODELCO
Michilla	С	Antofagasta Minerals
Spence	С	BHP Billiton
Sierra Gorda	СGМ	KGHM
Centinela	CG	Antofagasta Minerals
Gabriela Mistral	С	CODELCO
Salar de Atacama	L	SQM
Lomas Bayas	С	Glencore
Zaldívar	С	Antofagasta Minerals/Barrick Gold
Escondida	С	BHP Billiton
Franke	С	KGHM
Atacama Region	Products	Company
Salvador	СМ	CODELCO
NuevaUnion (development)	СGМ	Teck Resources/Goldcorp
La Coipa	GS	Kinross
Maricunga	G	Kinross
Ojos del Salado	CG	Lundin Mining
Candelaria	CG	Lundin Mining
Caserones	СМ	Lumina Copper
Coquimbo Region	Products	Company
Carmen de Andacollo	С	Teck Resources
Altos de Punitaqui	С	Glencore
Los Pelambres	СМ	Antofagasta Minerals
Valparaíso Region	Products	Company
El Soldado	С	Anglo American
Andina	СМ	CODELCO
Santiago Metropolitan Region	Products	Company
Los Bronces	СМ	Anglo American
O'Higgins Region	Products	Company
El Teniente	СМ	CODELCO

C = Copper M = Molybdenum L = Lithium S = Silver G = Gold

Source: Consejo Minero



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