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CHILE MINING 2022



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Dear Reader,

On March 11th, 2022, former student protest leader Gabriel Boric was sworn in as Chile's president. The election of the 36-year old's Social Convergence party signifies a distinct move politically to the left in a country looking for change, following social unrest that started in 2019 and led to a 2020 national plebiscite that voted overwhelmingly to draft a new constitution. The contents of the new constitution have been debated thoroughly throughout 2022, with a draft to be sent for public vote on September 4th.

What do the new constitution and the new government mean for Chilean mining? Global Business Reports (GBR) has conducted over 100 interviews with leading industry figures in the first half of 2022, as well as conducting site visits to speak with those on the ground. Initially, the sentiment in the country was one of cautious optimism. Minister of Mining, Marcela Hernando, and leading figures from Codelco, have been aligned in their message that Chile is open for business and will welcome investment. However, the rejection of a number of high-profile mining projects since Boric's appointment and the proposed increase in taxes suggest that the mining-friendly rhetoric may not be fully aligned with practical reality.

On one hand, high copper and lithium prices and increasing demand for electromobility offer a generational opportunity for Chile, as the world's largest copper producer and second largest lithium producer. On the other hand, as environmental thresholds become ever more stringent, even leading mining jurisdictions such as Chile are struggling to expedite project development at the pace necessary to produce the metals and minerals required for global decarbonization.

The issue of sustainability has become an evergreen topic that dominates both mining and public policy, as was evident from the talks given at the World Copper Conference during CESCO week in Santiago, March 2022. In the case of Chile, a 12-year drought has highlighted the need for collaboration and investment into desalination to tackle a critical challenge.

To cover these topics and provide a comprehensive annual guide to the different companies involved in Chile's mining value chain, GBR presents 'Chile Mining 2022' Industry Explorations report, an up-to-date review of the current operations, projects and latest trends in one of the pre-eminent global mining jurisdictions.

We thank all of our interviewees and partners for their time and collaboration. We also thank you for choosing Chile Mining 2022 as your source of information about Chile's mining industry and hope it can contribute to a successful year ahead.



Alfonso Tejerina
Director and General Manager,
Global Business Reports
(GBR)

This research has been conducted by Ben Cherrington and Mariolga Guyon
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 Graphic design by Gonzalo Da Cunha
 Graphic layout and artworks by Özgür Ergüney

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Introduction to Chile Mining

Constitutional changes and the impact on mining: ESG, Renewable Energies, Investment Climate, Sociopolitical Dynamics

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Production and Development

Investments and streamlined development are needed to capitalize on a generational opportunity: Copper, Lithium, Precious Metals

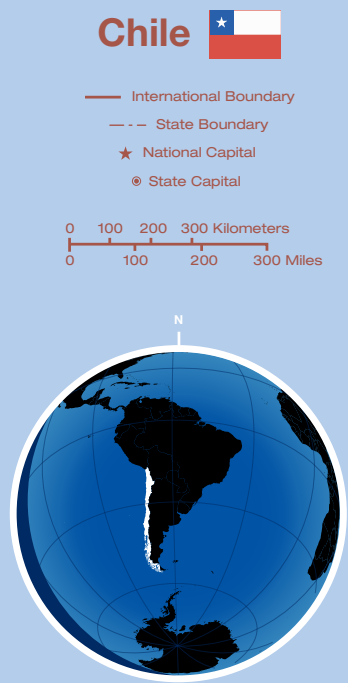
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“The country’s investment portfolio stands at US\$60 billion, which is remarkable. The challenge is to execute these investments. To achieve this, it is essential to have regulatory stability, as these are long-term investments”

**- Joaquín Villarino,
CEO,
Consejo Minero**

INTRODUCTION TO CHILE MINING

GBR • Industry Explorations • CHILE MINING 2022

Image courtesy of Freeport McMoRan

An Evolving Constitutional Landscape

Can Chile maintain its position as the premier mining jurisdiction in Latin America?



Image courtesy of Antofagasta plc

On March 11th, 2022, Gabriel Boric was sworn in as Chile's president, one month after his 36th birthday and a decade after emerging as a student protest leader. The election of Boric's left-wing Social Convergence party is the latest surge of the so called pink tide in Latin America, following leftist leaders rising to power in Mexico, Argentina and Peru in recent years.

Boric's appointment, which came on the back of social unrest in 2019 that led to a 2020 national plebiscite that voted overwhelmingly to draft a new constitution, seems to have drawn the attention of mining industry commentators to a greater extent than the aforementioned appointments elsewhere in Latam. After all, as the world's biggest producer of copper and second biggest producer of lithium, what happens in Chile impacts global industry. Considering the current focus on decarbonization, the role of Chilean metal production in the

electrification transition has amplified this importance.

A number of legislative proposals raised concern in late 2021 and early 2022, including a bill that would create the heaviest tax burden among major copper-producing nations, and a proposal to nationalize 'strategic assets' such as copper and gold. At the time, click-bait headlines and a lack of nuance surrounding the reporting of the proposed changes created concern about the gravity of what is happening in Chile, or rather what is likely to happen in the months and years ahead.

Until the end of April, the consensus on the ground in Santiago from investors, consultants and mining professionals alike was that radical changes are unlikely to occur, and there was a feeling of cautious optimism. However, the rejection of Anglo American's application for a US\$3 billion expansion of its Los Bronces copper mine in May 2022, followed by the rejection of the

EIA for Rio2 Limited's Fenix Gold project in July 2022, both turned down on questionable ground by Chile's environmental agency (the SEA), are serious red flags that indicate project development under the Boric government will not be straightforward. Both projects are expected to move ahead eventually, but serve as examples of the challenges faced in Chile, even by leading companies with strong track records in their respective spaces.

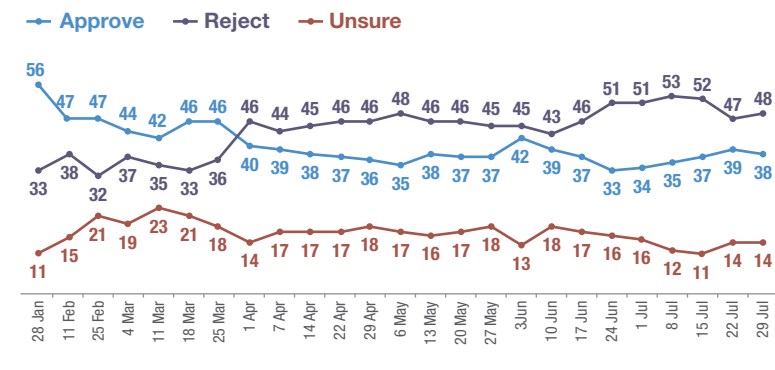
Furthermore, the current period of inertia as the country prepares to finalize its new constitution not only causes uncertainty, but could represent an opportunity lost during a time of high copper and lithium prices.

On May 15th, Chile's constitutional assembly rejected article 27, which planned to nationalize parts of the mining sector. Proposals, including general bans to mining activities in certain territories and a confiscatory royalty of 25% of sales, were also rejected. Article 25, which states that miners must set aside 'resources to repair damage' to the environment and harmful effects where mining takes place, did get a supermajority and will be in the draft constitution. However, this was the only one of the 40 proposals made by the Environmental Commission that was approved during the first votes in the general assembly.

"Up to now (May 27th, 2022), what has been approved does not go against the development of mining activity," commented Joaquín Villarino, CEO of Consejo Minero, Chile's industry association whose members represent over 90% of the country's mining production. "Recognizing that the mineral resources belong to the State is already

Constitution Approval Poll

With the information you currently have, would you vote to approve or reject the constitution proposed for the exit plebiscite in September this year?



Source: Cadem

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What is the vision of the Boric government regarding the Chilean mining industry?

If you look at the figures from the last decade, the mining industry represents over 10% of the GDP, so it is probably our biggest source of wealth. In terms of challenges, the climate crisis, which in our country has meant years of drought, requires a better mining industry that can provide metals in a sustainable and responsible manner. We must not only advance towards the decarbonization of mining, but also towards tracking and monitoring the mining industry's emissions, using well-defined reporting standards, and formalizing the industry's commitments to switch to renewable sources of energy. As a country we have bet strongly on renewable sources of energy since 2014, and the drought means we need to boost the use of seawater in mining, as well as leading an industry discussion around circular initiatives to maximize the reuse of water. In addition to this, we need to tackle the issue of mining waste and environmental liabilities.

What potential is there for further exploration and discoveries of large deposits, and what can be done to increase the participation of junior companies?

We see current exploration investment in Chile as insufficient, as most exploration projects are brownfield initiatives to extend existing operations. We would like exploration to open the door to new developments, so we aim to make the necessary regulatory changes to increase legal certainty for those who are willing to invest in exploration. With regard to a greater participation of junior companies, ENAMI has a great role to play there, and not just in metals, but also non-metallic minerals.

What impact could tax and constitutional reforms have on the attractiveness of Chile for investment?

The fiscal framework is an important factor for investors, but not the only one. There are others such as political stability and social peace. The world is witness to how the Chilean people can reach an understanding and solve



Marcela Hernando

Minister of Mining,
GOVERNMENT OF CHILE



For companies, changes to the tax regime are an investment towards social stability and security for their businesses in the long run.



conflicts via dialogue, even if we had intense social protest in 2019. We are working to make Chile a much fairer country in the relationship between industries and the population. For companies, changes to the tax regime are an investment towards social stability and security for their businesses in the long run.

Can you elaborate on the government's plans for Chile's lithium mining sector?

Chile is the second largest producer of lithium in the world, but we produce lithium carbonate for the most part. In the future, we are also interested in producing lithium metal and lithium for batteries. President Boric's government is mandated to create a state-owned lithium industry that could take various forms, such as a state-owned company or a public-private partnership.

How can environmental liabilities such as tailings dams be transformed into assets that can be remediated through profitable metal extraction?

I have always admired the creativity and innovation of Chilean engineers who have devised technologies to face the challenges of an industry in constant change, for example, deteriora-

tion of mineral grade, energy costs, water supply, etc. Today there are ways to process something that years ago was considered waste. Tailings contain great wealth, so there is an opportunity to profitably remediate these environmental liabilities. Minera Valle Central in Rancagua is a good example of how these deposits can be reprocessed. We have identified these liabilities and intend to stimulate both public and private investment in this area.

How is the government promoting the sustainable use of water sources and what are mining companies doing in terms of incorporating new technologies in this segment?

We have an interministerial committee around the issue of water, and one of the first agreements is to build shared infrastructure. The quickest solution to water scarcity is to install desalination plants, but desalination has a limit, because those plants also have an environmental impact. Therefore, if we install desalination plants, we must ensure that these facilities can support not only mining companies but also the agricultural segment and the general population. In the longer term, the goal is to have an interconnected water system, to have an efficient distribution of this resource throughout the country. ■

part of the current constitution. Other measures approved related to sustainability and environmental protection are also items that we consider to be reasonable.”

The final draft of the new constitution is due in July and citizens will vote to approve or reject it on September 4th. There is no guarantee that it will pass, as spiraling inflation and currency devaluation have resulted in public opinion souring against Boric. By July, opinion polls showed that over 50% of the public would reject the constitutional based on current information, with numbers trending against the heavily politicized document. If rejected, a further round of discussion and negotiation will be necessary, which could be better for the mining industry in the long term.

Reasons for optimism, but only if conditions are met

There were clear reasons for the sector to temper its concern during CESCO week 2022, the key industry event in Chile’s mining calendar that brings together the region’s major copper players in Santiago. On March 28th, Patricio Vergara, vice president of mining resources and development at Codelco, the world’s largest copper producer, announced that Chile’s state-owned mining firm was preparing to offer the market some ‘non-core’ exploration assets to become eventual partnerships.

The following day, during the opening keynote presentation at CRU’s World Copper Conference, Minister of Mining Marcela Hernando, stated that it was not in the government’s plans to nationalize mining in Chile or expropriate assets, adding that the government does not want to scare off investment. She underlined the will to work with exploration companies that “have placed their trust in our country”, and praised the way foreign companies treat their workforces.

Minister Hernando was previously mayor of Chile’s biggest mining region, Antofagasta, and chaired a mining committee in the lower house of congress for over three years. “She has a lot of experience and knowledge about the industry. Importantly, she is very open and in previous interactions has

always listened to the concerns of the mining sector,” commented Marcelo Awad, executive director of Wealth Minerals, who was CEO of Antofagasta PLC during Hernando’s time as mayor of the region.

During her interview with Global Business Reports, Minister Hernando affirmed the importance of maintaining Chile’s leadership position in mining, “with an attractive proposition in terms of legal and social stability.” She also underlined the need to promote a fair mining industry that treats its communities well and provides a fair contribution to the State.

The importance of establishing a clear legal framework was emphasized by BHP’s president of minerals Americas, Rag Udd, who announced that the world’s largest mining company intends to invest more than US\$10 billion in Chile, but only if certain conditions are met. “Mining is a long-term activity that requires very specific conditions, and we have been very clear about what those conditions are: fiscal stability, legal certainty and clear pathways to permitting,” explained Udd, before affirming his conviction that the country will provide the conditions for BHP to materialize the plans it has for Chile.

Joshua Olmsted, president and COO Americas at Freeport-McMoRan, acknowledged the “huge opportunity” for continued investment in the Chilean mining industry, but also made clear this is dependent on how legal frameworks progress over time. “Uncertainty in the last couple of years has caused a number of us to step back and see how this plays out before we make any major decisions on future projects,” reflected Olmsted, hinting that Freeport would probably be moving faster with the expansion of its El Abra project if there was more clarity around the fiscal and regulatory issues in Chile. He concluded: “We are hopeful that the process will conclude in a manner that will be beneficial to all parties.”

On the topic of how Chile’s mining sector strike a balance between attracting sufficient investment for growth and creating more local benefits for Chilean communities, Iván Arriagada, CEO of Antofagasta PLC, stated: “I believe the two come hand in hand – with greater

growth, including that fueled by investments, we will be able to give back more to our communities.” He noted that Chile is experiencing change with a new government and new constitution, and in both cases an emphasis is being placed on a more progressive social agenda and potentially higher taxes for the mining industry.

“I think that mining, and business more broadly, can play a significant part in this new social pact to create a balance that allows businesses to continue to grow and invest in the country, which, in turn, allows them to return more benefits to the communities,” added Arriagada.

Analyzing the type of government Boric intends to run, Michael Cullen, managing director Latin America for FTI Consulting, suggested: “Chile’s new president will try and implement something along the lines of Scandinavian welfare state politics rather than old-school communism.” Cullen observed that the government’s ministerial appointments have alleviated market fears, most notably finance minister Mario Marcel, who previously successfully ran the Chilean central bank from a fiscal management point of view.

Diego Hernández, president of Chile’s National Mining Society (SONAMI) and former CEO of Codelco, is optimistic that a compromise will be reached because of mining’s importance to Chile’s development, representing 14% of GDP in the last 10 years, 20% of the economy once the service sector and salary recirculation are considered, and 60% of the country’s exports.

The statements made by Minister Hernando and Codelco executives in recent months indicate that the government understands the financial realities of governing a country, particularly in a post-Covid landscape, are very different from populist rhetoric used during a campaign trail. However, the recent actions of the SEA go against the promising rhetoric from the Ministry of Mining. Chile’s mining sector already has very high environmental standards which are adhered to, as they should be, so denying development of two first-class projects (Anglo’s Los Bronces and Rio2’s Fenix) that have been run

the right way, is a warning sign that the rest of the industry and investors will be watching closely.

Potential risks

Although the most extreme constitutional proposals put forward to alter Chile’s mining industry have been rejected, one of the dangers is that the public discourse surrounding such radical ideas will influence a general public that does not fully understand the reality of mining. “I am going to reference German sociologist Niklas Luhmann, who suggested that a group of people with beliefs and a series of myths or values often end up deciding for an entire population,” said Manuel Viera, president of the Chilean Mining Chamber, who also acknowledged that Chile has been by nature a very conservative country.

David Alaluf, general manager of Endress+Hauser Chile and professor at the University of Santiago, voiced his concern that the current discourse surrounding Chilean politics is contributing to an uncertain climate for investors: “I am worried that new laws will be influenced by social networks instead of being based on technical fundamentals.” However, Alaluf praised the appointments made by the Ministry of Mining, citing the selection of subsecretary Willy Kracht as an example of the type of experienced mining professional the government should look to hire.

If radical proposals are unlikely to pass, what then are the main risks that Chilean mining has to navigate in the months ahead from a constitutional standpoint? Two of the potentially more problematic focuses of the new constitution revolve around decentralization and the environment, particularly water rights. The empowerment of regional authorities, while attractive in theory, often leads to extra avenues for corruption and cumbersome bureaucracy, as seen in the years following the Peruvian decentralization process in 2005.

María Paz Pulgar, counsel – natural resources, at Philippi Prietocarrizosa Ferrero DU & Uría (PPU Legal), observed that the environmental threshold for mining projects is significantly stricter today, communities have become more

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Contact:

SGS Chile
cl.servicioalcliente@sgs.com
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What are Consejo Minero's strategic objectives and priorities for 2022?

Consejo Minero is an industry association covering the country's major mining companies, be it Chilean or foreign, state-owned or private. We represent over 90% of the country's mining production. Our focus in 2022 is on public policy discussions on two fronts: Constitutional reform, which includes a chapter on mining, and a very important discussion about mining royalties. In parallel to that, we are part of the 'Compromiso Minero' initiative, that reunites over 100 institutions related to the mining industry. This includes big and small companies, mining providers, regional industry associations, and academic institutions.

How does Consejo Minero collaborate with the new government?

First, at Consejo Minero we gather and deliver a lot of valuable information to the authorities about the performance of mining companies. This government has shown interest in protecting small miners, and within that we can help a lot in terms of safety standards. Also, the previous government approved the 'Minería 2050' initiative, which needs to be implemented this year, and includes over 400 measures from emissions reduction to water usage and energy efficiency.

Regarding the new developments, we must see the final content of the new Constitution in other issues that can influence the industry, such as water resources, which will be subject to laws, so we will have to collaborate and work with the public sector and Congress.

What is Consejo Minero's view on the consequences that Chilean mining could face due to constitutional changes?

Up to now (27th May, 2022), what has been approved does not go against the development of mining activity. Recognizing that the mineral resources belong to the State is already part of the current constitution. Other measures approved related to sustainability and environmental protection are also items that we consider to be reasonable. What is pending for approval is the titles under which the private segment can undertake mining projects. So far, several proposals have been bad, including general bans to mining activities in certain territories; nationalization of certain min-



Joaquín Villarino

CEO,
CONSEJO MINERO



It is important to note that of all monetary flows in this industry, 90% stays in Chile via investment, taxes, royalties and salaries.



ing activities; and a confiscatory royalty of 25% of sales. Fortunately, all these proposals were rejected by the Constitutional Convention, so we are awaiting to see how other matters related to the industry are resolved, such as the use of water, community relations and rights.

What can the industry do to overcome a skills shortage?

For more than a decade we have been working on connecting the industry with education bodies, via the 'Consejo de Competencias Mineras' (CCM) initiative in alliance with Fundación Chile's 'Eleva' program. In general, most technical schools have very little knowledge about the profiles and skills that the industry needs, so we have been working with the Ministry of Education and Universities to address this gap.

How is Chile's mining sector working to strengthen regional employment and create wealth that stays in-country?

It is important to note that of all monetary flows in this industry, 90% stays in Chile via investment, taxes, royalties and salaries. For many years we have promoted that this wealth should stay in the mining regions. It is something we cannot control, but we believe there is a historic debt with the mining regions and the new Constitution is a good opportunity to address that.

Can you elaborate on the 'Compromiso Minero' initiative?

The Compromiso Minero initiative that was launched last year and looks at promoting industry visibility, sustainable development, the incorporation of more women to the industry, and innovation. We are working together to create a mining ecosystem, with partner institutions to promote these goals, because without copper and lithium, there is no electromobility, and without that, we can't fight climate change.

What is Consejo Minero's outlook regarding Chile's mining industry?

Chile has an enormous opportunity to be a very relevant player in the fight against climate change via the supply of minerals such as copper, lithium and cobalt. The country's investment portfolio stands at US\$60 billion, which is remarkable. The challenge is to execute these investments. To achieve this, it is essential to have regulatory stability. We also need to meet environmental challenges. A key challenge surrounds water consumption. Right now, Chile's mining sector only uses 3.5% of the country's water and we recycle 76% of that. However, we intend to improve this, and have a commitment to source 50% of our needs from seawater by 2030. Finally, another challenge is to build constructive relationships with the local communities. ■

What have been the biggest themes influencing APRIMIN's members in 2021 and 2022?

The biggest challenge was operating safely and maintaining operational continuity in a Covid environment. That meant mining professionals worked longer shifts with greater self-protection measures, which resulted in higher costs for the entire industry. Access to sites was more limited, so we had to get used to working remotely by whatever means necessary. However, despite all the challenges, I would say the system worked well. Chile has good connectivity and logistical support, and the high level of vaccination in the country helped things run relatively smoothly. Logistics was another big challenge, at both a local and international level. Because of these factors, costs have risen significantly.

The third theme has to do with the environment and our stakeholders. We are advancing towards sustainable mining, while at the same time developing renewable energy. During this transition, Chile has undergone significant political changes.

Which areas of the mining supply business do you see as having strong potential for growth?

Aprimin's associates cover the entire supply spectrum. If one looks transversally, we have all faced the challenge of being more efficient, while at the same time being more sustainable. So the larger companies with deeper pockets have been able to advance further from an innovation perspective.

Today, all the elements that operate in a mining operation produce data, and the big question is how to handle, manage, protect, and use that data effectively. The issues of cybersecurity, data protection, data management and analysis are all very big opportunities.

The evolution towards the use of renewable energy is another growth area.

To what extent do you think political changes, such as the proposed royalty bill, could impact Chile's mining landscape?

To our surprise, every time we meet with deputies and senators, it is difficult for them to understand the con-



Philippe Hemmerdinger

President,
ASSOCIATION OF INDUSTRIAL MINING SUPPLIERS
(APRIMIN)



We have to think that we live in a global village, and if Chile has a tax level that does not allow the mining sector to be relatively profitable, we will not receive investment.



cept of a sales tax vs an operating margin tax. We have to think that we live in a global village, and if Chile has a tax level that does not allow the mining sector to be relatively profitable, we will not receive investment.

In the last 15 years there has been a level of remittances in the order of US\$120 billion from mining companies to their subsidiaries as profits, but nobody remembers that in the same period there was also US\$120 billion in mining investment.

In summary, this form of taxation that has been advanced is not well thought out, but we still do not know what the final bill will look like. Also, many current investments were made with tax invariability, therefore these new taxes are not going to be immediate – some companies have invariability until 2030.

However, we are confident that finally the mining royalty bill will establish regulatory conditions that will keep Chile as one of the most competitive mining districts in the world.

What role can innovation play to help Chile maintain production levels?

This year, the Ministry of Mining and Energy delivered the national mining policy for 2050, which has several factors. One of the most important factors in this plan is sustainability, while many

operations in Chile have declining ore grades and are struggling with profitability. To tackle both these issues, an opportunity exists to reprocess tailings or ore storage facilities that were once considered uneconomic.

How does APRIMIN see the draft proposal for the new political constitution that is being proposed in Chile, specifically on mining regulations?

The wording and harmonization of the final text of the constitution is still being refined, and must be approved or rejected by the plebiscite on September 4th. However, the nationalization of copper, which was the main threat to the industry, was ruled out by a large majority. The expiration of current mining concessions was also rejected. Although there are other rules that cause concern, such as the absence of a way in which mining concessions will be constituted, which today is very precisely regulated at the Constitutional level. It is proposed that this will be left to the definition of simple majority laws, that uncertainty should only apply to future mining concessions, not for current ones, which must preserve the property right currently held by the mining concessionaires who own them. ■

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involved, and the perception and reception of the industry has changed. "Private water rights are strongly contested due to the alleged rights of indigenous communities which is aggravated by the drought Chile has experienced for the past years," she said, adding that this has led to proposals for new norms that aim to protect the environment and water supply, but would result in the detriment of the development of investment projects.

Although outright expropriation of water rights is unlikely, potential changes to the legislature surrounding water could still be impactful for mining, especially considering the amount of operations located in the Atacama – the world's driest desert. "In Colombia, for example, rivers have the same rights as human beings, and considering how delicate this subject is in mineral rich parts of Chile, radical constitutional changes could be taken that could have a bigger impact on mining operations than the royalty bill," stated Daniela Cuellar, senior consultant at

FTI Consulting, who mentioned FTI is watching this space very closely for its mining clients.

Another potential risk, or at least a challenge the Chilean mining sector has to deal with, is the inertia brought about by ongoing political and constitutional discussions. Chile is not used to experiencing the volatility of countries such as Argentina, Brazil or even Peru. This is causing things to move more slowly, as the country becomes familiar with operating through periods of change. For instance, some equipment suppliers mentioned that their sales to development projects such as Quellaveco and Marcobre in Peru were moving faster than development projects in Chile. It is an interesting comparison, because even though the majority of mining analysts believe Chile is still the premier jurisdiction in Latam for mining investment, the country must adapt to what is perhaps a 'new normal' of volatility (on both a global and regional level) to ensure development happens at the required pace.

Gabriel Boric is part of a new generation of leaders that want to make tangible change for a greener, fairer and more inclusive country. To achieve this, he has an enviable natural resource endowment that will not only play a leading role in the energy transition, but also has the potential to fund the initiatives that will enable change. "Governments should be focused on creating long term sustainable value rather than focusing on the short term," concluded Eduardo Valente, lead consulting partner at EY Chile.

At such a crucial time for the country the hope is that a constitutional framework will be established that can foster mining development for the years to come. As the world transitions away from fossil fuels and if copper really becomes the new oil, the opportunities awaiting Chile cannot be understated. It remains to be seen whether this will acted upon for the benefit of Chileans and global decarbonization, or squandered due to unrealistic ideologies that demonize responsible business. ■

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Chile's Constitutional Process and Royalty Reform Discussion: Navigating through uncertainty



Expert Opinion Article by
Francisco Acuña, Principal Consultant, CRU

Despite record high metal prices, which translates into healthy margins and positive cashflows, miners are still navigating through uncertainty in Chile as long-term planning has proven to be a difficult task.

Chile's mining sector has not been alienated from the socio-political turmoil the country has faced since late 2019. The exit referendum for the new constitution is set for September 4th this year, which is likely to be an inflection point that will define the political agenda for years to come. While mining has not been a central focus point of the constitutional debate, the Convention teased the idea of nationalization of the mining industry but it lacked support within the Convention. The final draft of the proposed constitution eliminated the most controversial mining-related articles, although the mining code and the mining concessions system will likely change, and more complex consultation processes to indigenous groups among other issues could have an impact, particularly for new mining projects.

In parallel, the royalty bill is still in discussion. The original bill introduced and approved in the Lower Chamber was modified in the Senate's Mining and Energy Commission early this year. The initial bill was extremely aggressive, and we estimated that it would have meant that all of Chile's copper production would turn to negative cashflows by the

end of the decade. This was moderated in the Senate, introducing a new royalty scheme that would have an ad valorem component and a margin-related component. With this, we estimated the average total tax effective rate could increase by approximately 5% with respect to the current scheme. This modification however was perceived as too moderate and did not have the necessary political support in the Lower Chamber to be approved. With this in mind, the new Government that took office in March this year stated that will be presenting a new royalty bill as part of their tax reform, which should be released by the end of June this year.

The green economy will sustain the copper consumption growth in the next decade. CRU expects that the supply gap for primary copper by 2035 will reach over 7 million tons. This means that the world will need a significant number of new mining projects. When we look at potential future production capacity, Chile has the potential to add 4.4 million tons of production capacity between probable, possible and specu-

lative projects. These projects would translate in approximately US\$41 billion in investment.

As the last committed projects will soon reach production, miners will have to take new investment decisions within the next couple of years. Will Chile remain in copper's pole position and bring to fruition its greenfield and brownfield projects? The reality is that even in the event that we don't see drastic changes in legislation and the constitution, it will still take time for the dust to settle. This means it will remain difficult for new investment decisions to be made, particularly for capex-intensive greenfield projects.

The forecast increase in demand for copper and growing supply deficit presents a unique opportunity for Chile. To capitalize on this, more certainty is needed to establish a framework for long-term investment. The new constitution represents an inflection point for the country and its mining industry that will dictate project development and economic progress in the years ahead. ■

The new constitution represents an inflection point for the country and its mining industry that will dictate project development and economic progress in the years ahead.

Francisco Acuña – Principal Consultant: Francisco joined CRU Consulting in 2019 and has worked on a variety of commodity types, including: base metals, precious metals and battery metals; and is engaging new business development with mining & financial institutions across the Americas. For further information, contact: www.crugroup.com/contact-us/

Chile's Sociopolitical Dynamics

A new government has been elected, a new constitution is being formed, and increased scrutiny on ESG has become an industry-wide focus



"While the social agenda that animated Boric's campaign may entail changes, the economic realities will ultimately sustain the close working relationship between the government and the private sector. The President understands the imperative necessity to continue to attract foreign investment and the indispensability of mining operations to the lifeblood of the Chilean economy. Moreover, there is a growing cognizance of the private sector's role, from generating tax royalties to funding local community programs, to effectuating any reformist policy."

- Cristobal García-Huidobro, CEO & Managing Director, Lithium Power International



"ESG is currently the biggest theme influencing the industry. This was demonstrated at CESCO week 2022, where 90% of the talks were related to ESG, with companies presenting plans on how to comply with zero carbon emissions as quickly as possible. Aligned with this, there has been great investment in environmentally friendly technologies and desalination facilities to mitigate challenges brought on by the drought in Chile, which has become structural. Successful management of community relations remains key to execute projects. Cost control is always a priority for mining companies to remain competitive at the low part of the cycle, given depletion of ore grades, financial requirements from stringent environmental standards, supply chain disruptions and inflation. Finally, uncertainties remain around constitutional reform that may negatively affect new investments, although the final constitution draft looks reasonable without proposing material changes to the industry."

- Alejandra Fernández Campbell, Director of Mining, Fitch Ratings



"Until this current constitutional process, Chile's legal framework has faced very few changes in the past 40 years. What has changed is environmental legislation – the threshold is significantly stricter today. Communities have become much more involved, and their perception and reception of mining projects has changed a lot. Authorities, NGOs and communities are much more critical and are constantly monitoring projects and the behavior of mining companies and contractors. Mining has a reputation of being the 'big bad wolf' and therefore building confidence today is more complex. The care and respect of the environment as well as the development of close and trusting relationships with stakeholders have become fundamental for mining projects."

- María Paz Pulgar, Counsel – Natural Resources, Philippi Prietocarrizosa Ferrero DU & Uría (PPU Legal)



"During the election campaign there was a perception, which was encouraged by Boric's opposition, that his coming to power would be a Chávez type moment for Chile. That was erroneous for a number of reasons, including the strength of Chile's institutions and the fact that the rhetoric used to energize Boric's left-wing base is very different to the reality of governing a country. The government's ministerial appointments, most notably finance minister Mario Marcel who very successfully ran the Chilean central bank from a fiscal management point of view, went a long way to alleviate market fears."

- Michael Cullen, Managing Director – Latin America, FTI Consulting



ESG & Renewable Energy

ESG has moved to front and center as industry priority number one

Image courtesy of Enel Green Power

There is currently a dichotomy surrounding global mining; of a world hungry for the metals and minerals required for decarbonization, yet reticent to streamline the permitting and development necessary to extract these raw materials. This is part of the reason why copper prices have remained robust in spite of a global economic slowdown and the Chinese lockdown – there is simply not the supply coming online to meet expected future demand driven by electric mobility.

Potential mining projects have no shortage of financing options at current metals prices. The principal reason development is not happening at the pace required is that the environmental and social permitting processes are more stringent than ever before.

Rohitesh Dhawan, president and CEO of the International Council on Mining and Metals (ICMM) sees ESG as the key theme, describing it as an evergreen topic that arguably has the most important influence on the industry's future. "We have eight years to halve greenhouse gas emissions, at a rate of emission reduction we have never seen before, if we are going to achieve the goals set out by the Paris accord," stated Dhawan, adding that the technologies necessary to achieve these ambitious targets are all dependent on mining, and the industry must step up not only to supply the amount of metals and minerals the world needs, but also achieve this in the most responsible way possible so that unintended harm isn't caused in the dash for metals and minerals. "This is not simply an environmental issue, as avoiding the worst impacts of climate change is intrinsically connected to social and economic issues," he added.

Alejandra Fernández Campbell, director of mining at Fitch Ratings, echoed this sentiment, pointing out that 90% of the talks at CESCO week 2022 in Santiago were related to the ESG, with companies presenting plans on how to comply with zero carbon emissions as quickly as possible. She commented: "Looking at the progression of environmental standards today in Chile, they are already complex and sophisticated. Any community member can go to court without needing legal representation and raise

a protection recourse when they feel that a project is affecting any of their constitutional rights."

This has caused the environmental process approval to take several years, with large projects averaging almost eight years to be ready for execution. Indeed, environmental issues have stalled a number of high profile mining developments in Chile. In December 2021, Chilean President-elect (at the time) addressed a crowd of supporters, announcing: "To destroy the world is to destroy ourselves

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– we don't want more sacrificial zones, we don't want projects that destroy our country and destroy communities."

During the speech, Boric promised to oppose Andes Iron's US\$2.5 billion Dominga copper-iron project, which critics suggest could jeopardize a biodiverse coastal ecosystem, and which has been in limbo for over a decade.

In May 2022, Chilean environmental regulator Superintendencia of the Environment (SMA) turned down the environmental permit application for Anglo American's US\$3.3 billion expansion of its Los Bronces copper mine. The decision followed an earlier recommendation by the Environmental Assessment Service of Chile (SEA) to reject the environmental permit application for the Los Bronces Integrated Project (LBIP) based on an alleged inability to completely eliminate doubts regarding the project's public health risks.

While there have been numerous recent success stories of permitting and development, such as Teck's QB2, Antofagasta Minerals' Los Pelambres expansion and BHP's Spence Growth Option (SGO), the delays to the aforementioned project and fines handed out by environmental bodies illustrate that even companies with large budgets and dedicated ESG teams face an elevated level of compliance today. This is not a passing trend brought in by a left-wing government, but a global movement whereby citizens expect more from industrial actors.

From a sustainability standpoint, one thing Chilean mining has on its side is that the metals and minerals it produces in bulk, namely copper and lithium, are inextricably linked to a greener future. Furthermore, the country has the geological endowment to supply an even wider range of 'future-facing' minerals. Aclara Resources, a company spun out of Hochschild Mining, acquired the BioLantánidos Ionic Clay Rare Earth deposit from Chilean private equity firm Minería Activa, and is looking to produce dysprosium (Dy), terbium (Tb), neodymium (Nd) and praseodymium (Pr) – rare earth elements (REEs) that are components of high-performance permanent magnets.

Ramón Barúa Costa, Aclara Resources' CEO, explained that as the com-



Aclara's objective is to become a strategic supplier of critical REEs which are required to manufacture the permanent magnets to enable the widespread use of renewable energy technologies and the increased adoption of EVs globally.



- Ramón Barúa Costa, CEO, Aclara Resources



pany gained more knowledge about ionic clays, three distinctive advantages came to light: "The metallurgy is extremely simple, which allows for a simple and environmentally friendly method of mining. It contains highly coveted heavy rare earths, especially those that have magnetic properties; and ionic clays do not contain radioactive material which is normally associated with rare earths."

Aclara's objective is to become a strategic supplier of these critical REEs, affirmed Barúa, with the company aiming to produce HREE carbonates with approximately 92% purity that have a low environmental and social footprint.

The renewable energy boom

While conducting interviews with major mining companies, one of the most noticeable trends is the concerted push to use more renewable energy to power operations.

Pablo Varela, managing director of Aggreko in Latin America, a company that supplies bespoke energy solutions and storage to power isolated mines, discussed Aggreko's partnership with Gold Fields at its Salares Norte project, where Aggreko is working on Gold Fields' first hybrid installation and the largest photovoltaic solar installation in Chile.

"Aggreko has committed to deliver power to the Salares Norte project for the whole life of mine, which is initially 10 years, but will likely be extended. We will start by providing diesel and solar solutions, but have committed to improve the technology as the availability of newer innovations comes to the market."

Expanding on the type of solutions being evaluated for installing batteries at Salares Norte, Varela revealed that Aggreko is considering installing virtual gas pipelines to the site. "We currently have several small power plants running at different sites and already began construction on the main power plant which will first run on diesel while we are working on the environmental approvals to install the solar PV solution," he said, adding that ironically it currently takes longer to attain a solar approval than a diesel approval.

One of the biggest players in the energy sector, Enel, has a gross installed capacity of 8,200 megawatts (MW) in Chile, which represents 28% of the total installed capacity in the country, according to Fabrizio Barderi, CEO of Enel Chile. "70% of Enel's generation capacity in Chile is CO2 emission free, given that a large portion comes from hydroelectric, wind, solar, and even geothermal plants," revealed Barderi, adding that the company intends to install an additional 3,300 MW capacity over the next three years, which will increase its CO2 emission free generation to 80% of production by 2024.

Giving examples of Enel's work with mining companies, Barderi cited a collaboration with Anglo American to develop the first electric depot in the mining sector in Chile, which supplies energy charging services to 17 E-buses that transport Anglo American's employees from the city to their mining operations. Barderi went on to mention Enel's partnership with SQM to bring the first large tonnage E-truck to the Chilean

market, commenting that for Chile to fulfil its potential to become a zero-emission country, it is important to push forward the consumption of electrification.

On the topic of alternative power sources, Juan Andrés Méndez, general manager of energy solutions at Gasco, remarked that waste energy recovery, something Gasco has developed in other industries, could make a big impact on mining. "Mining companies have a large accumulation of waste, such as wood pallets, that we can combust in an environmentally friendly way to avoid being disposed or transported. We can also work with food waste that through anaerobic processes can be treated and returned as an odorless fertilizer and biogas," he said, elaborating: "The latter, in combination with LNG or LPG, can supply the entire demand of hot water for a mining camp. We also supply LNG or LPG motors that generate power more environmentally and cheaply than traditional generators."

With the energy transition in mind, companies are rebranding to better

represent the focus and direction their business is heading. In October 2021, Hitachi ABB Power Grids became Hitachi Energy. Mauricio Mazuela, Hitachi's general manager for Chile, explained why this is relevant in a Chilean context: "In the coming years, about 50% of the power in Chile will come from the sun and the wind, and energy is now being seen from another point of view by the population. That is why we evolve our branding; if the world of energy is evolving, we must evolve."

Mazuela remarked that there should be a country-wide commitment to install clean energy, because new lines and plants are needed: "Supplementary systems, like solar farms, as renewable as they might be, will not yield sufficient energy during the night. Therefore, a hybrid mix of different energy sources is necessary."

Another company to have rebranded in 2021 is OHLA (formerly OHL), signifying the new owners' focus on sustainable construction and renewable energy projects, such as wind and solar

design engineering, including battery storage systems, explained Thomas Aldunate Kunstmann, business development manager renewables Latam – industrial division. Kunstmann pointed out that according to the International Renewable Energy Agency (IRENA) Chile and Mexico have the world's highest levels of sunlight, and OHLA uses bifacial modes to transform this sunlight into energy, as well as using string inverters to enhance operational reliability and efficiency at the plants, which reduces prices. He also echoed Mazuela's statement that big mining companies must utilize a hybrid combination of sources because they require constant energy.

Discussing the themes driving demand for renewables in Chile, Kunstmann highlighted water stewardship: "Companies utilize desalination to use water from the sea, which requires an enormous amount of energy. Renewable energy sources can facilitate this process and will gain traction as more desalination projects are built." ■



Rohitesh Dhawan

President & CEO INTERNATIONAL COUNCIL ON MINING AND METALS (ICMM)

Are the net zero goals set by countries realistic?

If we do things the way we have already done them, we will never achieve net zero. Supply chains are becoming more circular, but it is not happening quickly enough.

The critical shortage of metals is a very real risk that financial markets and governments have not appreciated. Typically, it takes between eight and 15 years to open a new large-scale copper mine. Currently we produce around 20 million t/y of copper, and by 2030 we need to produce approximately 30 million t/y of copper. If all the current copper projects come on stream exactly as planned, we will see an added 5 million t/y of supply, which would still leave a 5 million t/y deficit by 2030. When you open a mine, a new project can involve anywhere between 500 to 800 individual permits, and over the course of a project there can be approximately 5,000 different permitting obligations.

What could the industry do to im-

prove local community development?

ICMM completed a Social Progress Report in 2021 where we assessed a range of countries where mining is a critical part of the economy, looking at indicators related to sustainable development goals such as health, education, jobs and basic social economic services. The data clearly shows that mining-dependent countries have achieved faster progress on social and economic indicators than non-mining dependent countries. Chile was at the top as a well-governed country where the benefits of mining have been shared with the population, with salaries in the Chilean mining sector 70% higher than the country average.

Why then are we still seeing vast amounts of discontent? As an industry we need to accept responsibility for the fact that people are hesitant to have new mining projects in their backyards, because evidently there have been enough negative environmental or social incidents to give people reasonable cause for concern. ■

Can you elaborate on the power solutions Aggreko provides to the mining sector?

Aggreko is a proud partner to the mining industry in all stages of power for the mining life cycle, from exploration to closure. The company offers a wide range of bespoke energy solutions, often the main source of power in isolated mines, using the latest fuels and storage solutions. We recognise our position as partners in the energy transition and are constantly evolving our products to provide better solutions. Whether it is diesel, gas, hybrid or HFO, Aggreko can provide power, heating and cooling systems ranging from day hires to 20-year contracts, as we offer flexible agreements to suit any situation.

Can you elaborate on Aggreko's partnership with Gold Fields at the Salares Norte mine, working on the company's first hybrid installation and largest photovoltaic solar installation in Chile?

Aggreko's partnership with Gold Fields started 15 years ago in Australia, at the Granny Smith gold mine. Initially we provided them with diesel rental solutions, and later moved to gas, battery and hybrid solutions to align their power consumption with their environmentally-focused approach.

Gold Fields approached us during the planning stages of Salares Norte to come up with the best sustainable power solutions for this large scale development. The flexibility of our contract is a great advantage and Aggreko has committed to deliver power to the Salares Norte project for the whole life of mine, which is initially 10 years, but will likely be extended. We will start by providing diesel and solar solutions, but have committed to improve the technology as the availability of newer innovations comes to the market.

We are already evaluating new solutions for installing batteries for such a large scale project, installing virtual gas pipelines to the site, and other opportunities to improve power sources within the mine. We currently have several small power plants running at different sites and already began construction on the main power plant



Pablo Varela

Managing Director – Latin America
AGGREKO

↘↘
From a cost perspective, operating on solar becomes favorable after approximately eight years, if compared with thermal.



which will first run on diesel while we are working on the environmental approvals to install the solar PV solution. Ironically, it takes longer to attain a solar approval than a diesel approval.

To what extent can renewable energy sources reduce the carbon footprint of a mining operation?

When operating in remote areas, power generation is a necessity. The traditional solution has been thermal power, but carbon emissions are high in this process. Companies are starting to look at power generation sources which have a lesser impact on the environment, such as solar. The challenge is that one cannot rely 100% on solar due to penetration limits, and therefore hybrid solutions have been receiving great attention. Solar penetration is generally up to 30%, but by adding batteries one can increase penetration, depending on the investment. There is also a focus on switching from diesel to gas, which can significantly reduce a project's carbon footprint.

How do you think political changes in Chile could impact the landscape for investment in renewables?

It is difficult to predict the way forward with the new administration. Clarity on regulations and policies will be greatly beneficial in attracting FDI as certain-

ty that contracts will be respected increases investor confidence. Chile has always been transparent and the main mission of the new government is to show that they can continue providing clarity to investors regarding rules and regulations.

The cost of solar energy has reduced considerably in the last decade. Today, how does it compare with traditional forms of energy from a cost/benefit standpoint?

From a cost perspective, operating on solar becomes favorable after approximately eight years, if compared with thermal. Thus, if an operation will not last that long, it will be more beneficial to use thermal power, unless you can get a redeployable thermal asset as we are offering today to some of our mining customers for their construction phase. A battery solution is also required for using power during the night, but this is still expensive. Hybrid solutions utilizing a combination of solar, water, thermal, diesel, or gas resources are still the best option today as they are the only way to guarantee a consistent power supply. Interruptions in power supply can greatly impact on a mining operation and it is important to implement a power solution which is reliable, sustainable, and cost efficient. ■



Fabrizio Barderi

CEO
ENEL CHILE

Can you provide overview of Enel in Chile?

Enel Chile covers all the activities of the company's global business which is focused on power generation, distribution and transmission. Our service company Enel X - a leader in the sector of advanced energy solutions, complements our operations. Enel Chile has a gross installed capacity of 8,200 MW, which represents 28% of the total installed capacity in Chile. We are proud that already 70% of our generation capacity in Chile is CO2 emission free, given that a large portion comes from hydroelectric, wind, solar, and even geothermal plants. We continue to invest in renewables in Chile and intend to install an additional 3,300 MW capacity over the next three years, which will allow us to increase our CO2 emission free generation to 80% by 2024.

Could you highlight a standpoint project Enel is working on with a major mining company in Chile?

In collaboration with Anglo American, Enel has developed the first electric depot in the mining sector in Chile – developing a new innovative charging as a service business model. The Anglo American electric depot supplies energy charging services to 17 E-buses which transport their employees from the city to their mining operations. ■



Juan Andrés Méndez

General Manager – Energy Solutions
GASCO

How have Gasco's energy solutions evolved?

One of the biggest challenges is how to replace diesel and oil. On this journey, Gasco started with liquified natural gas (LNG), and we have also started working with alternative solutions such as solar. Something interesting we have developed in other industries which could make a big impact in mining is waste energy recovery. Mining companies have a large accumulation of waste that we can combust in an environmentally friendly way to avoid being disposed or transported. We can also work with food waste that can be returned as an odorless fertilizer and biogas, the latter, in combination with LNG or LPG, can supply the entire demand of hot water for a mining camp. We also supply LNG or LPG motors that generate power more environmentally and cheaply than traditional generators.

Another important energy development is the rise of hydrogen; we have been taking part in the HIF (Highly Innovative Fuels) project in Magallanes, which will produce hydrogen derivative fuels such as eGLP, a green, renewable fuel; and dimethyl ether, another renewable fuel. These initiatives are aimed at providing more sustainability to the country's power supply, in the north, specifically for mining. Throughout history, Gasco has been a pioneer in showing it is feasible to take more sustainable paths. ■



Mauricio Mazuela

General Manager – Chile
HITACHI ENERGY

What is the company's experience with renewable energy projects in Chile?

In Chile, Hitachi Energy has worked on over 30 renewable energy projects of great volume, above 30 MW. Through these projects, we have contributed to almost 7 GW of renewable energy into the system that is mostly consumed by our clients from mining and industry.

How do Hitachi Energy's digital, optimization and communications solutions apply to mining?

Hitachi's mining solutions are transversal regardless of what is being extracted. For example, our Digital Enterprise solutions collect and analyze data for predictive maintenance prognostics, and optimize the handling and maintenance of the company assets. We also have APM (Asset Performance Management), to effectively manage asset health costs, and Workforce Management that optimizes the use of human resources. These solutions allow companies to easily visualize and incorporate assets and people into their processes. Finally, we have the traditional portfolio as high voltage equipments, transformers, automation, systems and all the necessary equipment to supply and distribute energy within mining processes.

Regarding communications, Hitachi has a useful technology for mining called Tropos Networks, which are very reliable and ultrafast with an amazing broadband width, allowing for stability for digital systems. ■

Mining Investment Climate

Clarity is needed to stimulate a virtuous cycle of investment

For many years, Chile's position as the top mining investment destination in Latin America was clear, particularly for major developments. Moreover, mining has been the main driver of the country's socioeconomic development for decades. The historic stereotype of predatory international mining companies pillaging developing countries' resources and disappearing with the profits is far removed from how modern mining has operated for many years, particularly in mature jurisdictions such as Chile.

"It is important to note that of all monetary flows in this industry, 90% stays in Chile via investment, taxes, royalties and salaries," observed Joaquín Villarino, CEO of Consejo Minero, the Chilean industry association covering the country's major mining companies that represent over 90% of the country's mining production.

For many years, the taxes and royalties paid by Chile's mining sector have been the go-to source of income that

its government has used to fund other parts of the economy. Eduardo Valente, lead consulting partner at EY Chile, gave the example of the government mechanism to stabilize fuel prices for the population, which the State intends to fund with revenue attained from the copper industry in 2021. "If you do not create the conditions for investment, there will no longer be revenue to be used in other segments of the economy," stated Valente. "If the Chilean government invests in copper, companies can grow, will pay more taxes, and the government will have more revenue to invest in other sectors."

Porphyry copper projects are massive operations that generate tax wealth and employment for decades, as well as immense downstream value. If Chile were to develop its known reserves, even without exploration success, the country could increase its copper production by around 2 million t/y, and its lithium production by around 1 million

t/y. "The revenue from this production would generate vast wealth for Chile that would dwarf the extra taxes being discussed on current mines, in addition to creating thousands of jobs and indirect benefits for millions of Chileans," reflected Marcelo Awad, executive director of Wealth Minerals.

Philippe Hemmerdinger, president of the Association of Industrial Mining Suppliers (APRIMIN), emphasized the importance of the US\$120 billion invested into Chilean mining in the last 15 years from the perspective of the country's vast ecosystem of suppliers and those who live from this chain. Underlining the need to foster competitiveness, he said: "We have to remember that we live in a global village, and if Chile has a tax level that does not allow the mining sector to be relatively profitable, we will not receive investment."

The uncertainty that the noise surrounding constitutional and royalty reform creates is perhaps more significant than the actual reforms themselves, which are not expected to be drastic. The likes of BHP and Freeport have been clear in their communication – there is capital to be invested, but only under the right conditions.

In addition to the major producers active in Chile, the international investment community is watching what is happening closely. Michael Scherb, founder and CEO of Appian Capital Advisory LLP, discussed his company's view of political risk: "We view politics very much like we view commodity prices – a pendulum on a clock swinging back and forth, side to side, but rarely in equilibrium down the center."

Scherb commented that if politics moves against foreign investment in

the mining sector, investors will simply choose to put their capital in a different country, but political moves to the left wouldn't necessarily stop Appian from investing in a country.

Randy Smallwood, president and CEO of Wheaton Precious Metals (WPM), weighed in on the subject: "We are happy to take on geological, metallurgical, mining, engineering and even community risk to some extent, but we will not take on political risk ourselves."

WPM's global portfolio of streams is Americas-centric, including two investments in Chilean developments in 2021 for Rio2 Limited's Fenix Gold project and Capstone Copper's Santo Domingo project.

Martín Valdes, partner and head of Fund VII at Resource Capital Funds (RCF), acknowledged that in light of the constitutional reform, the investment community sees Chile with different eyes than it used to before 2019. However, he

observed that investment is still coming into the country and affirmed that investors believe that Chile will remain an attractive mining destination. Valdes sees plenty of upside left in the copper space when considering current valuations: "Despite high copper prices, copper producers, developers and juniors are currently trading around 0.6 or 0.7 times P/NAV, so I believe there is still value in this space. RCF is also interested in the gold sector considering everything going on in the geopolitical space."

Michael Scherb commented that while Appian always tries to be counter cyclical to the market, and the level of bullishness surrounding copper is slightly worrying, it is potentially a unique occasion. "We don't see where the supply is coming from, we don't see the ability to easily ramp up brownfield deposits, and we don't see a lot of exploration success. At the same time, we do see demand getting stronger," said

Scherb, reflecting that even if Chinese construction was to slow down, Appian's view is that the energy transition would more than make up for this. He added: "If a way to economically process low-grade ores was found, that is one of the only areas I see that could dramatically affect copper."

Pedro Pablo Lizana, CEO of Minería Activa, the mining arm of Activa, LarraínVial's private equity fund, believes there should be no shortage of transactions in the coming months and years considering the current prices and outlook for copper, highlighting Minería Activa's Pampa Camarones project as an example of green mining: "Pampa conducts its operations with solar energy and sea water. This company is a perfect example that, even in the light of climate change challenges, opportunities arise: it is possible to conduct mining operations that produce copper under green conditions." ■



If enough medium-sized companies with competitive projects are active in Chile, it would add significantly to the country's production. I think there is interesting room for growth there, and it has the advantage to be within reach of national investors. If we compare Chile with Peru and Mexico, for example, they have a lot more medium-size mines, producing 20,000 to 50,000 t/y copper equivalent.

– **Diego Hernández,**
President,
National Mining Society of Chile (SONAMI)



Image courtesy of BHP



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Michael W. Scherb

Founder & CEO
APPIAN CAPITAL ADVISORY LLP

How can credit solutions be structured so it's a win-win for all parties? Part of the reason that the credit market is available to specialist lenders like Appian is because there are not enough traditional financing solutions out there. Mining is a very capital-intensive sector, whose product is crucial for society, yet traditional banking does not want to invest because they cannot quantify the technical risk associated. The alternative would be very dilutive equity capital raises, whereas debt financing uses your balance sheet to minimize dilution. In effect, being able to raise any kind of credit capital is net value accretive.

Everyone seems to be bullish about copper at the moment. Does this concern you?

It is slightly worrying that everyone is so bullish, but this is potentially a unique case because we don't see where the supply is coming from, we don't see the ability to easily ramp up brownfield deposits, and we don't see a lot of exploration success. At the same time, we do see demand getting

stronger. If a way to economically process low-grade ores was found, that is one of the only areas I see that could dramatically affect copper.

What could be done to start changing the public image surrounding mining? Mining is in everything around us, so metals need to be extracted in a socially-responsible way. This is something we champion at Appian by being a signatory to the UN-backed Principles for Responsible Investment and viewing ESG as a crucial element in all our investment decisions.

As well as mining companies being more transparent, governments could adopt a more constructive tone with the industry. Politicians should also be more realistic about developing new opportunities. There is also a lot of 'greenflation', where you have negative mining sentiment on one hand, and push for energy transition on the other. This will only lead to higher prices and more inflation. Governments therefore have a responsibility to allow mines to get into production unabated. ■



Martín Valdes

Partner & Head of Fund VII
RESOURCE CAPITAL FUNDS
(RCF)

What would you say are the most prominent risks for the Chilean mining industry?

I believe that from now onwards, no mining project will be approved with fresh water, and everything will need to be done with salt water. Desalination is thus becoming increasingly important in the Chilean mining industry. With Chile not being an exception, communities have always been crucial, but now with social media it is becoming more fundamental to foster good relationships with communities. Another important risk, with again Chile not being an exception, is around the royalty increases which has been in congress for approximately two years. I believe that congress will however be conscious to not impact the competitiveness of the Chilean mining industry internationally.

Considering high metals prices, how difficult is it to find good value for projects?

This depends on the commodity. RCF were firm believers that electric battery penetration would happen, so in 2019 we decided to look for invest-

ments in lithium, resulting in two deals; one in Australia and one in Argentina. We were early movers and entered the space before prices started to increase. Currently, the lithium market is extremely expensive and lithium mining companies are trading at remarkably high prices.

RCF sees the copper space in an interesting way and is conscious of price expectations regarding how companies are trading. Despite high copper prices, copper producers, developers and juniors are currently trading around 0.6 or 0.7 times P/NAV, so I believe there is still value in this space. RCF also remains interested in the gold sector considering everything going on in the geopolitical space.

Which areas of Chile's mining sector need to be clarified?

Permitting is something Chile can do a better job of in terms of providing more clarity in how the process should work. As mining is expensive, it is important to provide more certainty around early stage investments through transparency. ■



Randy Smallwood

President & CEO
WHEATON PRECIOUS METALS
(WPM)

In 2021, WPM announced streaming agreements in Chile for Rio2's Fenix Gold project and Capstone's Santo Domingo project. What attracted you to these companies and assets?

We had known about the Fenix Gold project for a while, but particularly liked Rio2's approach of not stretching itself on a capital basis, but rather opting for a staged approach to grow the mine. We also believe the Fenix Gold project has significant growth potential.

We have had a long relationship with the Capstone Group and had a stream with them for a number of years. We were honored to be selected to again work with Capstone and see the Santo Domingo project as very exciting, especially considering the potential scale of the project and variety of metals it contains.

As a streaming company, how can you offer value beyond the upfront payment?

The extent of our activity to develop mining projects has been significant. Over the last 15 months, WPM has com-

mitted US\$1.4 billion in investments, and we have accounted for over half of the transactions in the royalty and streaming space in that period. The company has now exceeded US\$10 billion invested into the mining industry worldwide, which is a significant milestone.

Can you elaborate on WPM's approach to ESG and new decarbonization fund?

ESG considerations have long been a part of our investment decision. One of the challenges the industry is facing, especially in the precious metals space, is power supply. You can electrify mobile equipment at sites, but if the power is still coming from a grid which is based off of fossil fuels, you cannot reach full potential. Most of the capital WPM supplies is generally to fund construction, such as Santo Domingo and Fenix Gold, and we want to work with partners to make sustainable decisions on how they source power. In February 2022, WPM announced a fund to help our partners reduce emissions through decarbonization and climate solutions. ■



Pedro Pablo Lizana

CEO
MINERIA ACTIVA

Can you provide an overview of Minería Activa's structure and portfolio of assets?

Minería Activa is the mining arm of Activa, LarrainVial's Private Equity Fund, which was founded in 2005 and has grown to have various branches including Energy, Venture Capital, Private Debt, Buy Out / Growth, and Mining. Minería Activa has AUM for approximately US\$260 million across the full mining lifecycle, from early exploration to production. We have a copper producing asset in Arica, Pampa Camarones, which produces approximately 8,400 cathodes per year and has an EBITDA of US\$35 million. We have a polymetallic project, Ciclón – Exploradora, which completed last year its feasibility with attractive economic results. We have the Indiana project where we are exploring and producing at a small scale; we hold an early-stage iron ore exploration project, Iman, as well as the Filipina project which is currently optioned to Nittetsu who are soon commencing a drilling campaign.

How does Minería Activa add value to assets?

We look to identify deposits with untapped potential and then develop these assets through drilling campaigns and studies. Another business strategy is to revive assets under distress. For example, Minería Activa acquired Pampa Camarones in 2016 when the copper operation was filing for bankruptcy. We then undertook a complete transformation of the operation until it reached ramp up in 2020. On one hand we have a private equity business model where we are looking for undervalued assets which we can turnaround, and on the other hand, we are open to exploration activities.

Can you give details of the sale of the BioLantánidos Ionic Clay Rare Earth deposit to Aclara Resources?

BioLantánidos is the first RRE project ever developed in Chile and it represents the beginning of a new industry critical for the electromobility and for the development of clean energy sources across the globe.

BioLantánidos sale represented a 4x multiple for our investors who trusted us to carry on with this innovative project. ■



“Copper producer countries can choose to be even bigger players in fueling the world’s need for copper, and they can also choose to play a substantial role to underpin the global megatrends of decarbonization, electrification and renewable energy. This is a unique opportunity.”

**- Rag Udd,
President Minerals Americas,
BHP**

PRODUCTION & DEVELOPMENT

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Image courtesy of BHP

Copper Production & Development

Investment and streamlined development is needed to capitalize on a generational opportunity

Image courtesy of Freeport McMoRan

Is copper the new oil? The red metal has traditionally been a bellwether for the global economy, but in the last two years a combination of dwindling physical stock, medium-term supply deficit, and bullish long-term demand fundamentals have driven copper prices to all-time highs in March 2022 (over US\$5.02/lb). Although lockdowns in China and recession worries saw copper sell off heavily in Q2 and dip below the US\$3.50/lb mark, the medium to long-term outlook remains robust.

The downward trend in copper inventories at Comex, Shanghai and LME warehouses since 2018 is threatening supply. Although new production coming online in 2022 from projects such as Teck Resources' Quebrada Blanca 2 (QB2) in Chile and Anglo American's Quellaveco in Peru should see 2023 levels increase, a deficit is expected from 2025 onwards.

It is not uncommon to face supply gaps, but what is different now is the challenge the industry is facing to swiftly bring projects into production. Speaking at the 2022 World Copper Conference in Santiago, Erik Heimlich, head of base metals supply at CRU, suggested that the global copper industry needs to spend more than US\$100 billion on new developments in order to close an annual supply deficit forecast to be 4.7 million tonnes per year (t/y) by 2030. In other words, building eight projects the size of BHP's Escondida in Chile, the world's largest copper mine, over the next eight years. To say that this is unlikely would be generous at best.

All of the above, and copper's integral role in the energy transition, point to higher copper prices. "The world will need twice as much copper in the next 30 years as it has used in the last 30

years," stated Ragnar Udd, BHP's president – minerals Americas.

As the world's biggest producer, Chile has a generational opportunity to leverage its endowment for the benefit of its population and all stakeholders involved in the country's copper value chain. However, to capitalize on this, vast investment and streamlined development is needed. In addition to the new constitution which is expected to be signed on September 4th, the mining industry will be watching what happens with development projects from an environmental permitting standpoint. If delays such as Anglo American's US\$3 billion Los Bronces expansion become the norm rather than exceptions, investment dollars could soon migrate.

For investments currently underway there is no shortage of capital available. State-run Codelco, the world's largest copper producer, announced pre-tax profits of US\$7.4 billion in 2021, compared to US\$2.1 billion a year earlier. The company produced 1.728 million t of copper in 2021, combining its own production of 1.618 million t with its stake in Freeport's El Abra and Anglo American's Sur. Codelco's current investments include the Rajo Inca expansion, which will extend life at the company's Salvador operations to 2070.

In April 2022, BHP inaugurated the new concentrator at its Spence project. "This will allow us to extend the life of the mine for over 50 years and to amplify BHP's contribution to Chile," affirmed Rag Udd, president minerals Americas.

Udd also elaborated on the proposed US\$10 billion investment that BHP intends to make if "the right conditions" of fiscal stability, legal certainty and clear pathways to permitting are estab-

lished: "This investment considers new mining infrastructure, optimizations of our existing assets, non-conventional tailings, eventually building a new concentrator, new leaching processing facilities, developing new mining areas and investments in decarbonization to reduce Scope 1, ultimately to net zero."

Iván Arriagada, CEO of Antofagasta, discussed the Phase 1 expansion of the company's Los Pelambres project, which is due to be completed in 2022: "As mining progresses at Los Pelambres, ore hardness will increase. The Phase 1 expansion is designed to compensate for this, increasing plant throughput from the current capacity of 175,000 t/day (t/d) of ore to an average of 190,000 t/d." Arriagada revealed that the expansion will increase annual copper production by an average of 60,000 t/y over 15 years, helping optimize throughput within the limits of the existing operating, environmental and water extraction permits, and creating up to 2,000 new jobs during construction.

Freeport McMoRan, the world's third largest copper producer behind Codelco and BHP, is working on ramping up production at its El Abra mine in Chile to pre-pandemic levels, which it expects to achieve later in 2022, according to Joshua Olmsted, Freeport's president and COO – Americas. Olmsted commented that Freeport is in the process of constructing a new leach pad to stack material on at El Abra and aiming for production in the range of 200 million to 250 million lb/y. He added: "The focus of the ramp-up process now is to revert back to a 24/7 way of operating, which is all about planning and scheduling rather than overcoming any technical hurdles."

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BY SUPPLYING RESPONSIBLY PRODUCED COPPER, FREEPORT-McMoRAN IS PROUD TO BE A POSITIVE CONTRIBUTOR TO THE WORLD WELL BEYOND ITS OPERATIONAL BOUNDARIES.

ELECTRIFYING THE FUTURE

FREEPORT
FOREMOST IN COPPER

What have been the main milestones achieved and challenges faced at BHP's Chilean operations in 2021 and 2022?

The last two years have been exceptionally important for BHP in the Americas. In this region we currently have two of the commodities that are key pillars of BHP's future-facing portfolio: copper and potash. We have increased our exposure to these commodities and we have strengthened our growth perspectives.

Regarding our Chilean operations, we have celebrated big milestones. For example, last month we inaugurated the new concentrator at Spence, that will allow us to extend the life of the mine for over 50 years and to amplify BHP's contribution to Chile.

Our progress on desalination has continued to progress on a mission that started 15 years ago, and that has allowed us to supply Escondida exclusively with desalinated water and to build a new desalination plant in Mejillones to supply Spence. Our transition to renewable energies is also important and we are on track to be 100% supplied by renewable energy sources by the mid-2020s.

Our progress on gender balance is also noteworthy. In 2022, we surpassed the crucial 30% of feminine representation, up from under 17% in 2016. We are on track to achieve our aspiration of reaching a gender balanced workforce by 2025.

I want to highlight BHP's Operating System (BOS) that defines a set of principles, practices and behaviours that make improvement a part of what we do every day.

COVID-19 has been one of the major challenges. Even though we were able to keep our operations running while keeping our workforce safe, the pandemic is still creating disruptions in our supply chain, while dealing with the effects of labour shortage.

At the World Copper Conference in March 2022 you announced that BHP will invest US\$10 billion in Chile under the right conditions. What type of conditions would these be, and where would the investment be directed?

Mining is a long-term activity that re-



Rag Udd

President Minerals Americas
BHP



When I say that the industry is at an inflection point, it means that we need to decide whether or not we are willing to take the right actions at the right time for saving the planet for future generations.



quires very specific conditions, and we have been very clear about what those conditions are: fiscal stability, legal certainty and clear pathways to permitting. I'm convinced that the country will provide the conditions for us to materialize the great plans we have for Chile. Under the right conditions, Chile will remain a world leader in copper production.

This investment considers new mining infrastructure, optimizations of our existing assets, non-conventional tailings, eventually building a new concentrator, new leaching processing facilities, developing new mining areas and investments in decarbonisation to reduce Scope 1, ultimately to net zero. The next five years will be crucial for executing these plans.

What progress has BHP made in Chile with regard to its water supply and energy use?

In Chile we have been pioneers in desalination: BHP was the first company to build a desalination plant and, over the last 15 years, we have invested US\$4 billion in desalination capacity. This has enabled Escondida to only use desalinated water and to stop extracting water from Andean aquifers. We also built a desalination plant in the Mejillones Port to supply desalinated water to the new concentrator at Spence.

Regarding energy use, we have made significant progress transitioning to renewables.

Can you elaborate on how BHP is eliminating diesel at its operations?

We are developing autonomy programs and pilots in our mines to transition to fully integrated and highly automated assets and value chain. We are collaborating with partners such as Caterpillar or Komatsu to design solutions to electrify our trucks and fleets. We are searching for disruptive ideas and we are always willing to listen to innovative solutions.

Why do you believe the mining sector is at an inflection point which will shape its future?

The mining sector has the potential to be right at the center of the changes that the world urgently needs.

Take copper as an example: copper producing countries can play a substantial role to underpin the global megatrends of decarbonisation, electrification and renewable energy. This is a unique opportunity.

So when I say that the industry is at an inflection point, it means that we need to decide whether or not we are willing to take the right actions at the right time for saving the planet for future generations. ■

The Phase 1 expansion of Los Pelambres is due to be completed in 2022. What will it mean for the company?

As mining progresses at Los Pelambres, ore hardness will increase. The Phase 1 expansion is designed to compensate for this, increasing plant throughput from the current capacity of 175,000 tonnes of ore per day (t/d) to an average of 190,000 t/d of ore. Importantly, annual copper production will increase by an average of 60,000 t/y over 15 years.

As such, the expansion will be transformational, helping us optimise throughput within the limits of the existing operating, environmental and water extraction permits, as well as creating up to 2,000 new jobs during construction.

Can you provide details of Antofagasta's digital transformation roadmap?

We are installing an integrated remote operations management centre for Centinela in the city of Antofagasta, which will transform ways of working for our colleagues by cutting travel time to and from the mine, as well as encouraging access into mining for more people, including women and the differently abled.

We have also developed a proprietary chloride leaching process for primary sulphides – Cuprochlor-T. This technology will allow us, over time, to produce copper cathodes from low grade primary sulphide minerals at reduced operating and capital costs, and with a smaller water and carbon footprint.

How does the company intend to utilize desalinated water through its INCO project?

One of the clear impacts of climate change is the 12-year drought in central Chile, including in the Choapa Valley where our Los Pelambres operation is located.

Several years ago, we took the decision to build a seawater desalination plant for Los Pelambres and the first stage of this project, with an output of 400 litres per second, is due to start operation in the second half of 2022. We are planning to double its capacity as soon as the necessary permitting is obtained. Desalinated and reused or re-



Iván Arriagada

CEO
ANTOFAGASTA PLC



Part of our climate change commitments includes the transition to renewable power and, by the end of 2022, all our electricity consumption will be renewably generated.



cycled water will then account for more than 90% of the mine's total production, freeing up some 500 l/s of water for surrounding communities. These efforts will help us progress towards our target for raw or desalinated seawater and reused or recycled water to supply 90% of the operational water use at all our mining operations by 2025.

Antofagasta intends to move to 100% renewable power. What steps must be taken to make this a reality?

Part of our climate change commitments includes the transition to renewable power and by the end of 2022, all our electricity consumption will be renewably generated. In July 2020, Zaldívar became our first operation to use 100% renewable energy, reducing our CO2 emissions by 67,614 tonnes at the time. In January 2022, Antucoya and Centinela also switched to 100% renewably-generated electricity and, later this year, they will be followed by Los Pelambres.

As part of this process, we have been renegotiating our power purchase agreements (PPAs), switching them from conventional sources – principally coal – to renewables. We are also focusing more on energy efficiencies to reduce both greenhouse gas emissions and operating costs. Finally, we joined the Chilean Hydrogen Association last

year to explore the use of green hydrogen as a replacement fuel to diesel in mining truck fleets.

How can Chile's mining sector strike a balance between attracting sufficient investment for growth and creating more local benefits for Chilean communities?

I believe the two come hand in hand – with greater growth, including that fuelled by investments, we will be able to give back more to our communities. At the moment in Chile, we are experiencing change with a new government and the ongoing process to write a new constitution. In both cases, we are seeing an emphasis on a more progressive social agenda and potentially higher taxes for the mining industry. I think that mining, and business more broadly, can play a significant part in this new social pact to create a balance that allows businesses to continue to grow and invest in the country, which, in turn, allows them to return more benefits to the communities.

Our commitment to our communities is at the center of all we do at Antofagasta. Principally, we are committed to building lasting and sustainable relationships with our different stakeholders in order to foster transparent dialogue and achieve mutually beneficial outcomes. ■

How was 2021 for Freeport-McMoRan in Chile from an operational perspective, and what is being done to ramp up production at El Abra in 2022?

2021 was a year of transition and planning for the future for Freeport in Chile, continuing to weather the storm with respect to Covid, but in the grand scheme of things it was very successful. In 2022, we have been working to ramp up El Abra to pre-pandemic levels, which we expect to achieve later in the year. Moving forward, we will be in the range of 200 million to 250 million lb/y of production. Concurrently, we are in the process of constructing a new leach pad to stack material on. During the height of the pandemic, we had been doing campaign maintenance and operations, and the focus of the ramp-up process now is to revert back to a 24/7 way of operating, which is all about planning and scheduling rather than overcoming any technical hurdles.

What potential do you see for expansion at El Abra to grow the oxide open-pit and develop the sulfide resource underground?

El Abra is a world-class resource that we have been drilling for many years to gain a better understanding of the ore body. It is a significant opportunity for us long term on the sulfide side. We are also drilling to see if there are opportunities to extend the current operation while we move forward with the sulfide planning. We have done a lot of work historically on the engineering side, but this year, the focus is on being prepared to submit an EIS for the mill sulfide project, as well as ongoing stakeholder engagement.

What could reforms to the Chilean constitution mean for Freeport's investments in the country?

There is a huge opportunity in Chile for continued investment in the mining industry, but it will be dependent on how legal frameworks progress over time. Uncertainty in the last couple of years has caused a number of us to step back and see how this plays out before we make any major decisions on future projects, because you



Joshua Olmsted

President & COO – Americas
FREEPORT-MCMORAN



Uncertainty in the last couple of years has caused a number of us to step back and see how this plays out before we make any major decisions on future projects.



need some degree of fiscal and regulatory certainty in the environment you are operating in. We would probably be moving faster on the El Abra project if we had more clarity. We are hopeful that the process will conclude in a manner that will be beneficial to all parties.

Can you provide examples of some of Freeport's most tangible ESG initiatives in Chile?

El Abra was the first operation in Chile to be certified under The Copper Mark, and Freeport is also a member of ICMM, so we work under those principals. We have been focused on the key issues surrounding ESG in Chile for many years, such as biodiversity, diversity, water and communities. El Abra was the first private mining company that was certified under Chile's voluntary gender equality and work life balance ordinance, for example. On the water side, we have partnered with communities in the Atacama since 2009 to provide desalinated water, and we continue to help operate and maintain this plant today.

At El Abra, the plant site is at lower elevation than the mine site, and in the 10 km between this there is a community called Conchi Viejo, which was really impacted by the storms

in northern Chile a couple of years ago. We worked hand in hand with the community to rebuild it, but also to think about how to prevent heavy damage if something like this happens again.

What is Freeport-McMoRan's broad strategy for expansion in the Americas?

We have been really focused on organic growth because we recognize there are opportunities within Freeport's existing assets. El Abra is a good example, as long as the conditions for investment make sense. In the US, our Bagdad operation in Arizona has over 80 years of reserve life, which offers an opportunity to increase the milling rate for which we are working on a feasibility study. More front and center would be our Lone Star operation in Arizona, which has been expanding incrementally over time through a debottlenecking process. Today, we are stacking at about 95,000 t/d at Lone Star, on the path to 120,000 t/d, before making a decision on the transition to a large sulfide operation, similar to El Abra.

Another focus has been digital analytics for the leaching part of the business to identify incremental copper production in the near term. ■

What is the current status of the Quebrada Blanca Phase 2 (QB2) construction and ramp up, and once in full production, what will this project mean for Teck Resources?

We are laser focused on the successful execution of our QB2 project in Chile as the first step in Teck's copper growth strategy, which will be transformational for our company. Construction of QB2 is on track and the project is set to start production in the second half of 2022.

Once in production, QB2 will double our consolidated copper production by 2023 and significantly reweight our portfolio more towards copper at a time when we see significant rising demand fueled by the transition to the low-carbon economy.

How has the company dealt with cost increases at QB2 related to COVID-19 and rising inflation?

We are continuing to actively manage costs and we have put in place a variety of mitigation measures and incentives, many of which are aimed at attracting talent, employee retention and minimizing absenteeism. In addition, our focus continues to be on managing COVID-19 and the extensive protocols we have in place to protect the health and safety of our employees, partners and communities.

Can you explain how Teck intends to use desalinated seawater in place of freshwater for its mining processes at QB2?

We are switching entirely to desalinated water for QB2 in order to protect local freshwater. It is important to mention that Teck voluntarily committed to return fresh water rights to the State of Chile as part of the QB2 environmental evaluation process. QB2 will have the first large-scale use of desalinated seawater for mining in Chile's Tarapacá Region. Seawater will be pumped to the desalination plant, purified, then pumped by five booster stations up 4,400 metres of altitude to QB2's concentrator plant, where it will be used for mining processes. The leftover concentrated saltwater will be pumped back into the Pacific Ocean at a depth of 40 metres (750 metres from the coast) to ensure there is enough dilu-



Don Lindsay

President & CEO
TECK RESOURCES LIMITED



We are laser focused on the successful execution of our QB2 project in Chile as the first step in Teck's copper growth strategy, which will be transformational for our company.



tion to be compatible with the ocean's ecosystem.

Can you provide details of the Quebrada Blanca Mill Expansion (QBME) prefeasibility study and the potential for Phase 3 expansion?

Our Quebrada Blanca Mill Expansion project, or QBME, would add another 150,000-plus t/y of copper equivalent production as early as 2026—increasing our throughput by at least 50%. This mill expansion would leverage existing QB2 project infrastructure to the fullest and be a key piece of our copper growth strategy. The pre-feasibility study is expected to be complete by end of this year and we will assess sanctioning following that.

QB2 only uses around 18% of the 2021 reserve and resource tonnage and the vast, long-life deposit is large enough to support multiple expansions which we will be looking at moving forward.

What are your views on Chile as a mining jurisdiction in the context of constitutional reform, and what could changes to the royalty bill mean for Teck's investments in the country?

Teck has operated in Chile for many years - it is a great mining jurisdiction. We are committed to working closely

with the new Chilean government to ensure we continue to benefit communities while operating responsibly. We support the efforts of the mining industry associations in the country that have publicly indicated that mining activities provide much more wealth than taxes paid, including jobs and social investments programs among other positive impacts. We are monitoring the royalty bill closely, and we believe that the discourse in Chile will reach a reasonable outcome that will allow for continued sustainable resource development.

How important is copper to Teck's future as a diversified mining company focused on the energy transition?

Copper is absolutely central to Teck's growth strategy. Copper is a crucial component in renewable energy systems and green technologies—from solar panels to wind turbines, electric cars and much more. It's a critical metal that will increasingly be in demand worldwide, with projections showing demand will double by 2030. And that makes it key to our growth strategy because not only will it be in strong demand in the years ahead, but it is also a key part of our commitment to responsible mining and providing the resources needed for the low-carbon future. ■

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When asked about the company's strategy for expansion in the Americas, Olmsted emphasized Freeport's focus on organic growth through expansion projects such as an extension of the open pit and the transition to sulfides at El Abra. "El Abra is a world-class resource that we have been drilling for many years to gain a better understanding of the ore body. It is a significant opportunity for us long term on the sulfide side," he added, noting that there has been a lot of work historically on the engineering side, but in 2022, the focus is on preparing an EIS for the mill sulfide project, as well as ongoing stakeholder engagement.

Chile's development pipeline

The importance of large mining development projects goes beyond production figures. Interviewing companies throughout the whole value chain for this report, the opportunities that projects such as Teck Resources' Quebrada Blanca Phase 2 (QB2) or Antofagasta's INCO development represent to Chile's vast ecosystem of suppliers and the thousands of families that live from this income cannot be understated.

QB2, one of the world's largest undeveloped copper resources, is currently under construction and set to start production in the second half of 2022, according to Don Lindsay, Teck's president and CEO, who described the project as the first step in Teck's copper growth strategy that will be transformational for the company. "Once in production, QB2 will double our consolidated copper production by 2023 and

significantly reweight our portfolio more towards copper at a time when we see significant rising demand fueled by the transition to the low-carbon economy," said Lindsay.

Lindsay also provided details of the Quebrada Blanca Mill Expansion (QBME) prefeasibility study and potential for Phase 3 expansion, which would add another 150,000-plus t/y of copper equivalent production as early as 2026—increasing throughput by at least 50% and leveraging existing QB2 project infrastructure to its fullest. "The pre-feasibility study (for QBME) is expected to be complete by the end of this year," affirmed Lindsay, noting that QB2 only uses around 18% of the 2021 reserve and resource tonnage and the vast, long-life deposit is large enough to support multiple expansions, which we will be looked at moving forward.

Another of the important development projects in Chile's pipeline is Capstone Copper's (formerly Capstone Mining) Santo Domingo project. In 2021, Wheaton Precious Metals (WPM) acquired a gold stream at Santo Domingo for US\$290 million. Randy Smallwood, WPM's president and CEO, spoke of his long-term relationship with Capstone Copper's executive chair, Darren Pylot, and outlined his enthusiasm for the project: "We were honored to be selected to again work with Capstone and see the Santo Domingo project as very exciting, especially considering the potential scale of the project and variety of metals it contains."

Monetizing an environmental liability

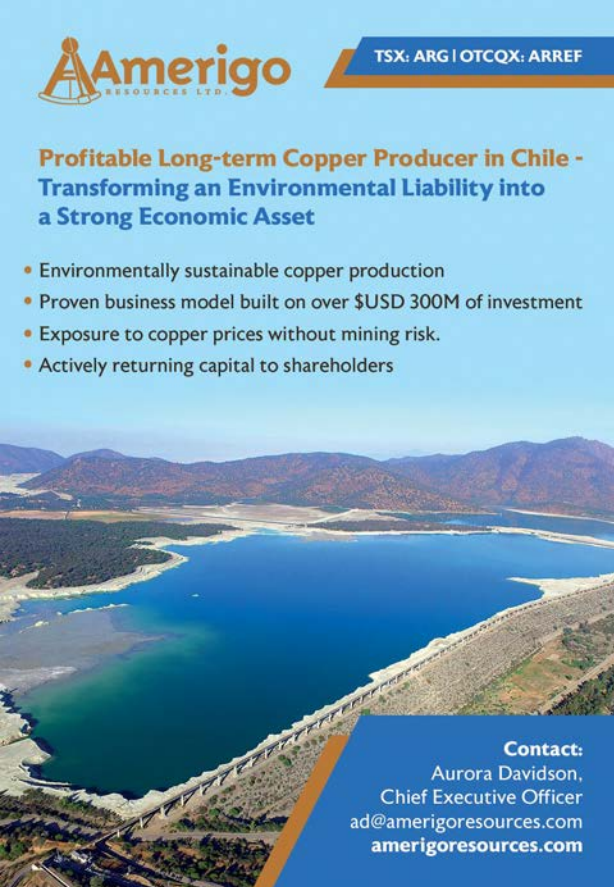
Both the demand for copper and the timeline it takes to move projects from exploration to production are increasing. To meet demand, the traditional means of production are insufficient and innovation is required. Clayton Walker, Rio Tinto's COO of copper, remarked that 100 million t of copper is estimated to be trapped in tailings deposits globally, which represents an opportunity for incremental production through reprocessing.

This is an opportunity that Amerigo Resources, through its Chilean subsidiary Minera Valle Central (MVC), has been working on since 2003. "We used to produce around 25 million lb/y Cu, but have grown this figure to 63 million lb Cu in 2021. This was achieved by investing US\$300 million into the facility, doubling the capacity of our concentrator plant, and incorporating the rights to process historical tailings," explained Aurora Davidson, Amerigo's president and CEO.

Amerigo gets its material through a contractual relationship with Codelco's El Teniente division, the largest underground mining operation in the world, where MVC has the rights to process fresh tailings and a series of historical tailings deposits. "Essentially, Amerigo works with an environmental liability – tailings – and extracts further economic value from that by producing copper concentrates," said Davidson, noting that MVC is by no means a small operation, as a tremendous amount of material has to be processed given the low grade that by definition is contained in tailings. "In many ways, we are more of a copper factory than a mining operation," said Davidson.

Under the leadership of Davidson, Amerigo has focused on improving margins and has overcome critical water supply issues through investments that include thickeners that increase water circulation efficiencies. In February 2022, the

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Profitable Long-term Copper Producer in Chile - Transforming an Environmental Liability into a Strong Economic Asset

- Environmentally sustainable copper production
- Proven business model built on over \$USD 300M of investment
- Exposure to copper prices without mining risk.
- Actively returning capital to shareholders

Contact:
Aurora Davidson,
Chief Executive Officer
ad@amerigoresources.com
amerigoresources.com

Can you explain Amerigo Resources' business model and the evolution of the MVC operation?

Amerigo produces copper, but we do not have a mining business model behind us that involves the typical long-term cycle of exploration, development and construction before production. Instead, we get our material through a contractual relationship with Codelco's El Teniente division, where we have the rights to process their fresh tailings and a series of their historical tailings deposits. Essentially, Amerigo works with an environmental liability – tailings – and extracts further economic value from that by producing copper concentrates. We are by no means a small operation, as we have to process a tremendous amount of material, given the low grade that by definition is contained in tailings. In many ways, we are more of a copper factory than a mining operation.

The Minera Valle Central (MVC) operation was founded in 1992 and purchased by Amerigo in 2003. We used to produce around 25 million pounds of copper per year, but have grown this figure to 63 million lb Cu in 2021. This was achieved by investing US\$300 million into the facility, doubling the capacity of our concentrator plant, and incorporating the rights to process historical tailings.

What do Amerigo's 2021 results and guidance for 2022 indicate about the state of the company today?

Every copper producer is doing well these days, but what has changed in the mentality of many producers compared to the previous high cycle is that we have gone through very harsh times in recent years. The industry has learned to survive under low copper prices, so it can thrive under high copper prices. Amerigo's focus is essentially on producing margin – not just how many more tonnes of copper we can produce, but how we can produce in the most economic way. Our team is very focused on three fronts: production; operational continuity; and financial performance. This approach to running the business and the effect of strong copper prices have dramatically improved the company's finances.



Aurora Davidson

President & CEO
AMERIGO RESOURCES



Amerigo works with an environmental liability – tailings – and extracts further economic value from that by producing copper concentrates.



How has the company resolved issues to guarantee a sustainable and economic water source?

The single most important water source for us is the water which comes with the fresh tailings. In addition, we have water rights at MVC, as well as three water thickeners that increase water circulation efficiencies. We can store surplus water at Colihues, which is an historical tailings deposit adjacent to MVC. Two years ago, we went through a critical situation with respect to water supply, and as a result we are closely monitoring our sources and uses of water eighteen months ahead at all times.

What potential is there to replicate the tailings processing work Amerigo does at other mines in Chile?

For many mining companies, tailings represent an inherent long-term responsibility and an environmental liability. On the other hand, grades are getting lower and the industry needs to look at ways to maintain production levels. The notion of tapping into tailings to derive further economic value is very compelling. However, producing copper from tailings is not easy and requires art and science, as no two deposits are alike. For example, even at MVC we have had to make adjustments to fine tune the processing of the fresh and historical tailings from El Teniente.

I think that when the right decision makers at mining companies start adjudicating the potential value to their existing tailings and see them as an opportunity to top up production, rather than just a liability, there could be tremendous opportunities for Amerigo given its existing operational experience. We are interested in exploring opportunities under the right conditions which include the size of the deposit and location, for example.

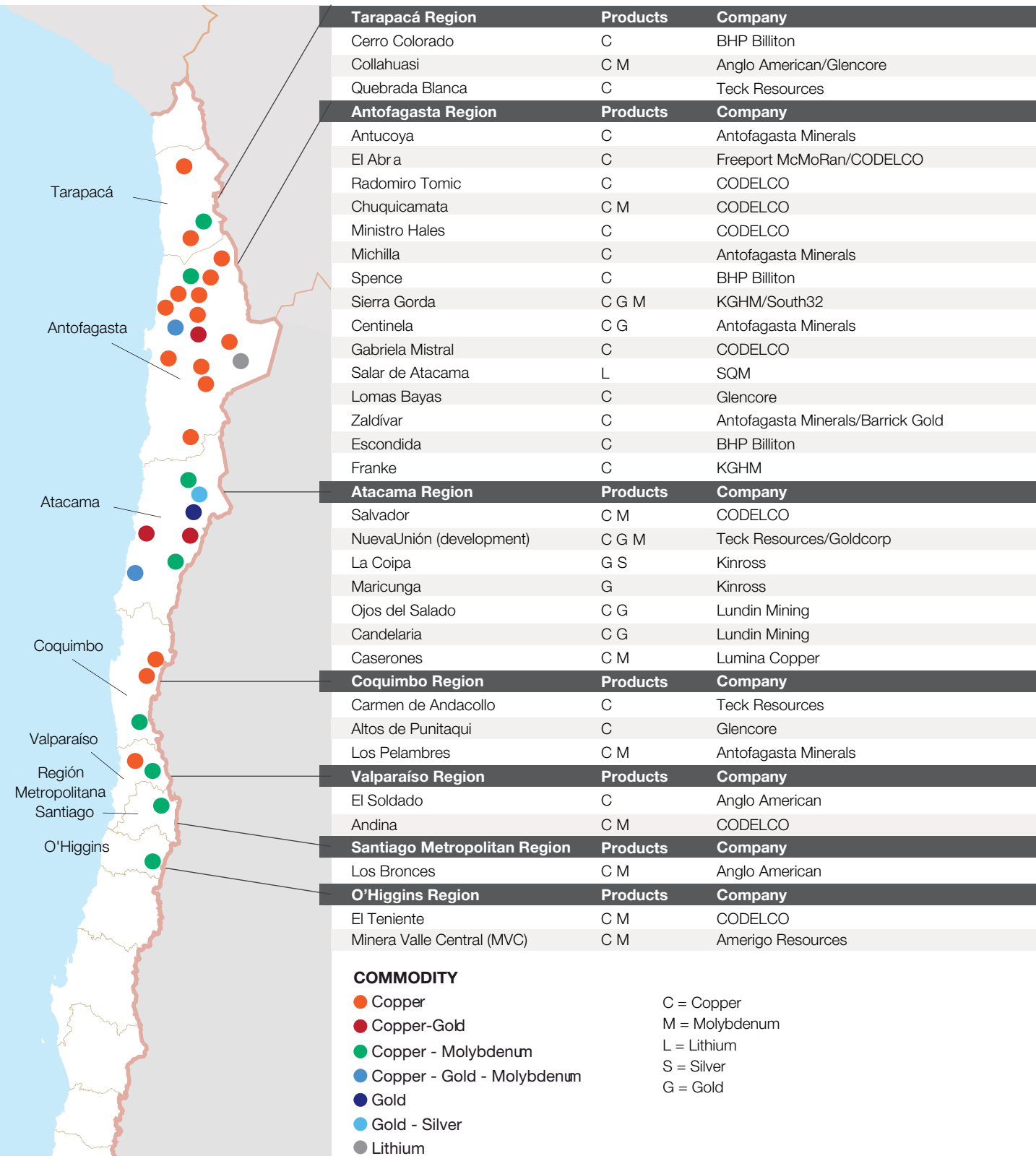
Which factors contributed to MVC receiving the 2021 San Lorenzo award from Chile's National Mining Society (SONAMI)?

We received the San Lorenzo (Chile's patron saint of miners) award for mid-tier mining companies essentially based on our innovative business model which economically produces copper through a process that no one else uses. Amerigo is the only company in the world solely focused on production through the processing of copper tailings on this scale.

MVC is also a highly respected corporate citizen in the region. MVC is essentially a suburban operation where most of our people live close to our facility, are from the city of Rancagua, and are proud of working for two strong employers in the area – El Teniente and MVC. ■

Production Map & Directory

Source: Consejo Minero & GBR



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company announced record revenue, which poses the question of what potential there is to replicate this business model at other mines in Chile?

"I think that when the decision makers at mining companies start adjudicating the potential value of their existing tailings and see them as an opportunity to top up production, rather than just a liability, there could be tremendous opportunities for Amerigo given its existing operational experience," said Davidson.

"Minera Valle Central in Rancagua is a good example of how other dams could be reprocessed in a similar way," stated Marcela Hernando, Chile's Minister of Mining, revealing that the government intends to stimulate both public and private investment in similar opportunities.

Stimulating medium-sized mining

The Chilean copper industry is the realm of majors, including the world's biggest copper producer (Codelco), biggest mining company (BHP), biggest open-pit mine (Escondida) and biggest underground mine (El Teniente). An economy

of scale is necessary to justify the capex for large copper projects, many of which are at altitude and are increasingly likely to use desalinated water. That being said, an opportunity exists for the country to develop its medium-sized mining segment if the government can create the right conditions. Minister of Mining, Marcela Hernando, mentioned that Empresa Nacional de Minería (ENAMI) could play a role in this development. "If enough medium-sized companies with competitive projects are active in Chile it would add significantly to the country's production. I think there is interesting room for growth there, and it has the advantage to be within reach of national investors," commented Diego Hernández, president of Chile's National Mining Society (SONAMI).

An example of medium-scale copper mining in Chile is Lumina Copper's Caserones operation, an open-pit mine located 162 km to the southeast of Copiapó at an average altitude of 4,300 meters above sea level. "We have two lines of production – a concentrator

where we process sulfides to generate copper and molybdenum concentrate; and a dump leach operation where run of mine material is leached and through an SX-EW process we produce high grade copper cathodes," detailed Gonzalo Araujo Alonso, COO of SCM Minera Lumina Copper Chile (MLCC).

In 2022, MLCC expects to produce a total of 150,000 t of copper, having overcome Covid-related challenges which lowered production in 2020 and 2021.

Caserones is located in a farmers' valley that had only one major mine established in the area before Lumina began operating, which Araujo mentioned has made attracting a local workforce a complex challenge. In an effort to overcome this, MLCC has started the Atacama Labor Integration Program (PILA), which seeks to train and hire people without mining experience from the Province of Copiapó, particularly Tierra Amarilla, into the company's operations, serving as an example of how the establishment of mining camps can stimulate local development. ■



Gonzalo Araujo Alonso

COO

SCM MINERA LUMINA COPPER CHILE

Can you provide an overview of SCM Minera Lumina Copper Chile's (MLCC) Caserones mine?

Caserones is an open pit mine located 162 km to the southeast of Copiapó at an average altitude of 4,300 m. We have two lines of production – a concentrator where we process sulfides to generate copper and molybdenum concentrate; and a dump leach operation where run of mine material is leached and through an SX-EW process we produce high grade copper cathodes. The SX-EW plant was commissioned in 2013 and the concentrator plant in 2014. In 2022, MLCC expects to produce a total of 150,000 tons of copper, mostly in concentrate with approximately 20,000 tons of cathodes.

I believe Caserones is a great learning school for medium-sized mines and serves as an example of how technologies and best practices can be implemented to make a challenging project successful and profitable.

What have been the main milestones achieved and the main challenges

What is MLCC's approach to hiring local talent for its workforce?

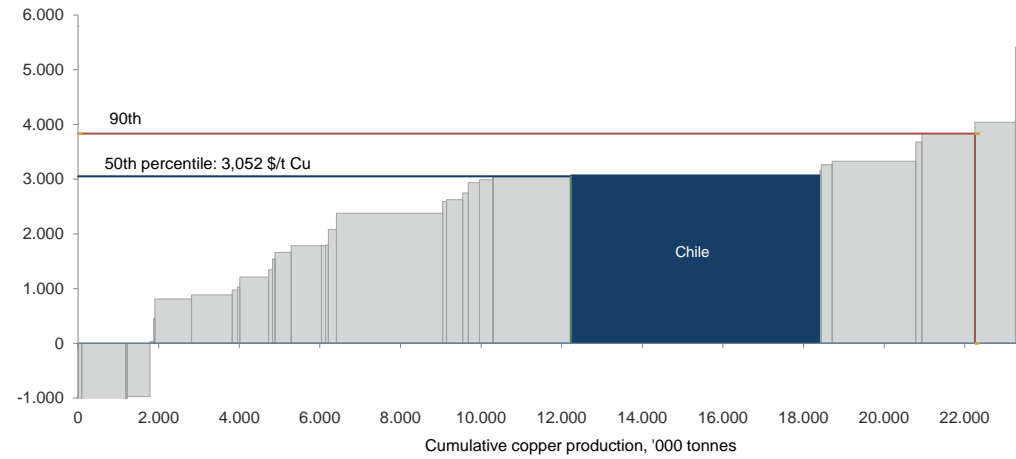
In previous years, MLCC saw significant improvements in its production profile with 2019 being our best production year ever. However, this curve of increased production, stability, and reliability of our operations changed with the onset of the pandemic when we moved into an organizational adjustment strategy to mitigate challenges. We are now at a stage where we are moving back towards more normal conditions and are again in the process of increasing reliability and production. We have had great results over the last three quarters and expect to continue on this trend moving forward.

What is MLCC's approach to hiring local talent for its workforce?

Attracting a workforce has been a complex situation as we are located in a farmers' valley with only one major mine established in the area before us. Today, we have a local workforce of approximately 33% which is the result of an effort we carried out together with our contractors. ■

Cash Costs

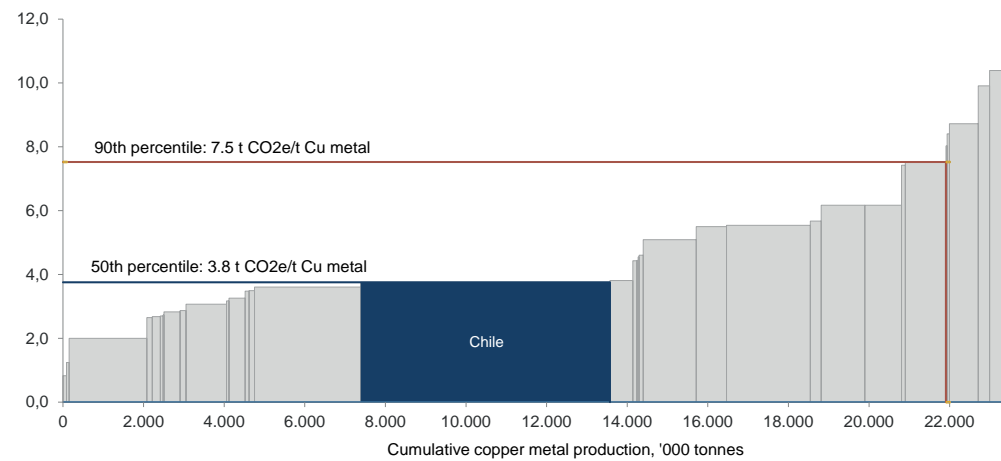
Weighted average CRU value-adjusted cash cost by country, 2022 (US\$/t Cu)



Source: CRU

Emissions

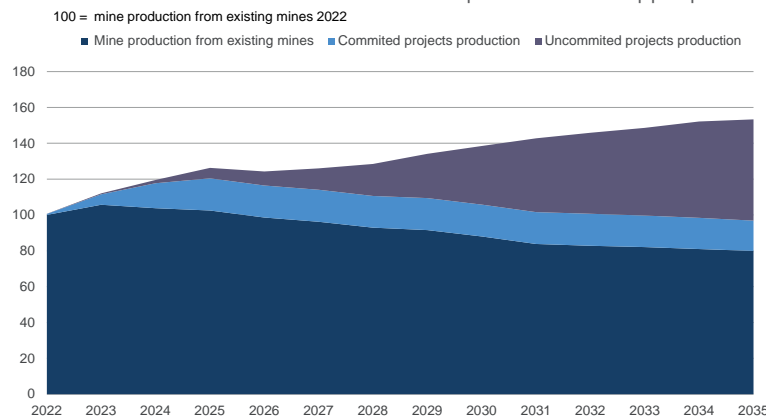
Weighted average CRU Scope 1, 2 & 3 CFR emissions by country, 2022 (t CO2e/t Cu metal)



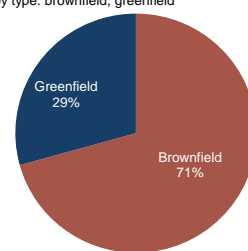
Source: CRU

Potential Mine Production – Indexed

Chile potential mine copper production

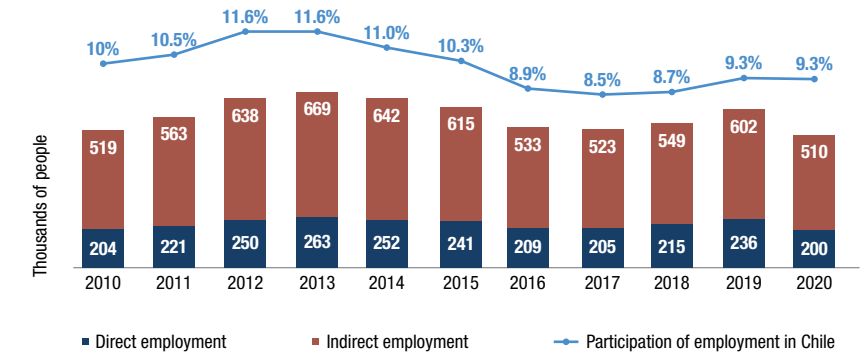


Share of potential production uncommitted projects in 2035
%, by type: brownfield, greenfield



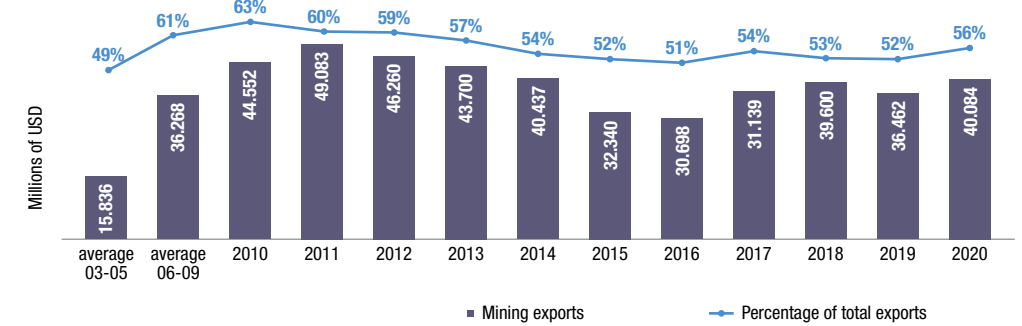
Source: CRU

Direct employment in Mining, Indirect employment generated in other sectors, and participation in Chile's overall employment



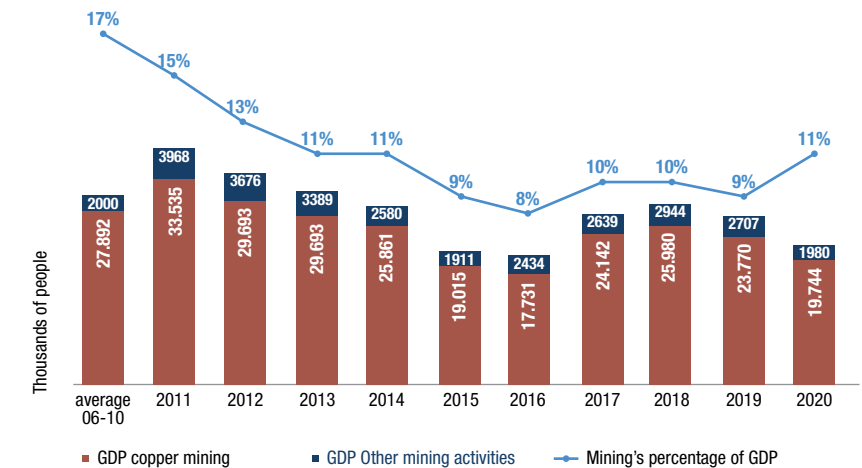
Indirect employment: 2.55 employees for each direct employee
Source: Consejo Minero from information from INE, 2021

Mineral exports and percentage of Chile's total exports



Source: Consejo Minero from information from Chile's Central Bank, 2021

GDP of the mining sector and percentage of Chilean GDP



Source: Consejo Minero from information from Chile's Central Bank, 2020

Lithium

How will the creation of a national lithium company take shape



Image courtesy of Albemarle

Lithium has been arguably the mining world's hottest commodity, rising in price by over 400% from 2021 to 2022, according to figures from Benchmark Mineral Intelligence. In April 2022, Elon Musk tweeted that the price of lithium had "gone to insane levels," to the extent that Tesla might have to get into the mining and refining directly at scale, unless costs improve.

Chile is the second largest producer of lithium, producing approximately 26,000 t/y in 2021, a record output for the country that is blessed with the largest known lithium reserves. As demand ramps up, driven by the electric vehicle revolution, it goes without say-

ing that producers have been making hay while the sun is shining.

For instance, Chilean miner SQM (Sociedad Química y Minera de Chile), one of the two lithium producing majors active in the country, reported a near twelve-fold rise in quarterly profit in Q1 2022, with net profit rising to US\$796 million and revenue nearly quadrupling to US\$2.02 billion. As industry profits have soared, governments around the world, including Mexico, Argentina, and now Chile, are looking to get more closely involved in the lithium space beyond the taxes and royalties they already receive.

While the idea of government intervention may raise red flags for investors

and private sector spectators, in the case of Chile the intention of the Boric government to create a new State-run company to advance lithium development has been received with cautious optimism by the country's industry. All lithium assets are owned by the Chilean Government since 1979, when Pinochet declared lithium and uranium strategic minerals. Because of this decree, there is currently a lot of red tape involved in producing lithium in Chile, and new developments outside of SQM and Albemarle have stagnated. The hope now is that the new vehicle can collaborate with the private sector and provide a clearer set of processes and guidelines to streamline development.

On May 22, 2022, Chile's Mining Minister, Marcela Hernando, told local paper La Tercera that the government hopes to establish a model for the new company by the end of the year, and that a specialized group was being formed to define the best way to operate the company. She reiterated that the government was open to the participation of private capital in the firm, with the State as the main shareholder, and that lithium would not be included in the plans to apply a mining royalty.

In her interview with Global Business Reports, Minister Hernando commented that the incorporation of electromobility worldwide to face the climate crisis presents an opportunity for Chile given the country's abundant lithium

**- Marcela Hernando,
Minister of Mining,
Government of Chile**



Chile is the second largest producer of lithium in the world, but we produce lithium carbonate for the most part. In the future, we are also interested in producing lithium metal and lithium for batteries. President Boric's government is mandated to create a state-owned lithium industry that could take various forms, such as a state-owned company or a public-private partnership.



and copper reserves. She went on to affirm that adding more downstream capacity is in the interests of the government: "Today, Chile is the second largest producer of lithium in the world, but we produce lithium carbonate for the most part. In the future, we are also interested in producing lithium metal and lithium for batteries."

Marcelo Awad, executive director of Wealth Minerals, suggested it would not be difficult to develop certain downstream capacity. "For instance, if you want to build a 25,000 t/y operation for lithium or hydroxide production, capex is around US\$600 million. Going downstream to lithium cathodes, one of the battery components, capex for the same production level would be around US\$100 million."

Gerardo Illanes, SQM's CFO, spoke of the company's investment plan that considers US\$2.25 billion between 2021 and 2024: "Regarding lithium in Chile, we are increasing our capacity from 120,000 metric tons of lithium carbonate to 180,000 metric tons that we are reaching now, and then reaching 210,000 metric tons in the middle of 2023."

Illanes observed that these capacity increases will be made while SQM reduces its extraction of brines from the Atacama Salar by 50%, on a voluntary basis.

The other of the major lithium producers in Chile, Albemarle, recently finalized the expansion of its chemical commercial plant in La Negra, which will increase the company's Chilean



The emergence of a national lithium company is far from a new development, as discussions about its establishment long precede the incoming administration. Establishing a national lithium company does not entail the monopolization of the entire value chain. Rather, public-private alliances will underpin the company, which can be a promising opportunity for lithium operations in Chile.



**- Cristobal García-Huidobro,
CEO & Managing Director,
Lithium Power International**



production capacity to over 85,000 t/y of lithium carbonate, according to Ignacio Mehech, VP external affairs and country manager in Chile. He also elaborated on the company's US\$100 million investment in evaporator recycling technology, which will allow Albemarle to reduce the consumption of fresh water at La Negra by approximately 30% per kilo of product. "The plant was commissioned in 2021 and its final product is currently in the process of qualification with customers. We expect it to be fully qualified by Q3 2022"

Mehech underlined Albemarle's enthusiasm regarding the creation of a national lithium company to build pol-

icy, create opportunities to add value to Chile's lithium sector, developing the value chain within the country, and also to investing more in R&D. He also pointed out that, as per the company's contract with CORFO (Chile's Economic Development Agency), which lasts until 2043, Albemarle pays the highest royalty or commission for lithium production in the world, which goes up to 40% of the final sale price of the product. He added: "We will contribute approximately US\$300 million in R&D funding to CORFO between 2016 and 2043, which has contributed to CORFO funding a center of E-mobility and a circular economy center in northern Chile." ■

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SQM reported its best quarterly performance in 1Q 2022, with an almost twelve-fold increase in earnings. What were the biggest contributing factors?

The results of the first quarter are the reflection of several positive circumstances and constant work: Large investments financed by our shareholders and bondholders, together with the great execution of an ambitious investment plan, and tremendous dedication of the SQM team.

In the lithium industry, we have seen a price increase associated with very strong growth in demand for electric vehicles around the world. At the same time, the investments we have made have allowed us not only to produce and sell larger amounts of product (with less consumption of brines from the Salar de Atacama), but also to develop products with greater added value, of better quality and which consequently are sold at higher prices.

In the iodine market, we have seen a strong recovery in demand, after the big drop we saw at the beginning of the pandemic. We are investing a significant amount to be able to increase our capacity by 1,000 t/y by the end of this year and another 2,500 t/y by the end of next year. We are doing all of this at the same time as we are in the process of developing a seawater pipeline that will allow us to significantly reduce the consumption of continental water. Finally, the fertilizer market has been affected by the situation in Eastern Europe, which has affected the potassium chloride supply chain, while logistical difficulties around the world have continued to put pressure on markets.

Can you provide details of SQM's US\$400 million investment to expand lithium carbonate production capacity?

We have a very ambitious investment plan that considers US\$2.25 billion between 2021 and 2024. Regarding lithium in Chile, we are increasing our capacity from 120,000 t/y of lithium carbonate to 210,000 t/y in the middle of 2023. This is a tremendous achievement because we are making these capacity increases while we are reducing our extraction of brines from the Ata-



Gerardo Illanes

CFO
SOCIEDAD QUÍMICA Y MINERA DE CHILE (SQM)



We have a very ambitious investment plan that considers US\$2.25 billion between 2021 and 2024.



cama Salar by 50%, on a voluntary basis. We are also investing in additional lithium hydroxide capacity, to reach 40,000 t/y, and incorporating technology that allows us to produce products with higher added value and better quality.

Additionally, we are increasing our iodine production capacity in Chile by 3,500 t/y, along with an increase in nitrate processing by more than 300,000 t/y. Finally, we continue to work on the development of the Mount Holland lithium project in Western Australia, together with our partners at Wesfarmers, in a 50/50 JV that will allow us to initially produce 50,000 t/y of lithium hydroxide.

Could you highlight some of SQM's ESG-related initiatives?

In 2020 we presented a robust sustainability program because our objective is to become not only leaders in production costs, but also to add to the best world standards in sustainability in our production of potassium nitrate, solar salts, iodine and lithium.

For example, we planned to reduce brine extraction in 2020, and that same year there was a 20% reduction, towards the goal of reaching 50% reduction by 2030. We are also lowering our continental water consumption in all operations to achieve a 40% reduc-

tion by 2030 and 65% by 2040. Additionally, we are investing to be carbon neutral in all our products by 2040, and in the case of lithium, potassium chloride and iodine by 2030. Additionally, we are committed to maintaining and deepening the responsible management of the natural resources used, working together with the communities to support the care and protection of these ecosystems.

How can a balance be found between the growth of the company and the care of indigenous interests?

SQM supports agreements that directly support the development of the communities for their life plans. An example of the direct agreements is the one signed in 2020 with the Community of Camar, which allows the development of a new form of associative relationship with a community with which a tense situation existed in the past for different reasons. This agreement established a standard to be considered for future agreements with communities originating from the Salar de Atacama.

General relationship agreements have also been signed with three other communities (Toconao, Rio Grande and Talabre) and we are in the process of signing at least three more general agreements with other communities. ■

Can you provide an overview of Albemarle's Chilean operations and production profile?

Albemarle is a pioneer in the Chilean lithium industry, having been present in the country for over 40 years. The company started lithium exploitation in the 1980s in a joint venture with the state through CORFO (Chile's Economic Development Agency). We recently finalized the expansion of our chemical commercial plant in La Negra, which will increase Albemarle's Chilean production capacity to over 85,000 t/y of lithium carbonate. Our operation is divided into plants; at the Salar de Atacama plant we extract and concentrate lithium brine, which is then transported to our La Negra plant close to Antofagasta where we produce the final product – battery grade lithium carbonate, created specifically for electronic devices, electric cars, and safety equipment markets.

Can you elaborate on Albemarle's investment in La Negra into thermal evaporator recycling technology?

The evaporator recycling technology allows us to reduce the consumption of fresh water at La Negra by approximately 30% per kilo of product. The plant was commissioned in 2021 and its final product is currently in the process of qualification with customers. We expect it to be fully qualified by Q3 2022. This US\$100 million investment forms part of Albemarle's commitment to a greener future and our effort to increase the sustainability of our operations.

What are your thoughts on the current discussions surrounding lithium mining in Chile?

The result of the Constitutional Assembly vote on 15th May was promising, as it appears to be moderate and balanced. We hope this enables a new era of prosperity in the country.

Albemarle is also excited about the creation of a national lithium company to build policy regarding lithium, create opportunities to add value in Chile, develop the value chain within the country, and also to invest more in R&D in the lithium space. The government is also open to partnerships between the public and private sectors to further develop the lithium industry in Chile.



Ignacio Mehech

VP External Affairs & Country Manager Chile
ALBEMARLE



We recently finalized the expansion of our chemical commercial plant in La Negra, which will increase Albemarle's Chilean production capacity to over 85,000 t/y of lithium carbonate.



Regarding how to add downstream capabilities to Chile's lithium sector, it is beyond the reach of one specific company to develop the value chain and is therefore all actors, including the government, private sector, academia and society must be involved.

What is the latest regarding the charges levelled by Chile's environmental regulator (SMA) related to the alleged over extraction of brine in the Atacama?

Albemarle has always been committed to operate sustainably and with full transparency. We thus provided information and posed a question to the SMA to clarify some aspects that were not clear about our permits. We are convinced that we acted with full transparency and there are no infringements. The SMA did however press charges against us, but we are collaborating with them and have already filed our response providing additional information to the authority.

What role will the company's Chilean operations play in supporting the company's growth?

We recently finalized the construction of our commercial plant in La Negra, which will allow us to double our capacity. We forecast that the lithium demand in 2025 will be approximately

1.5 million t, and that by 2030 it will be over 3 million t, so Albemarle is looking at various options around the world to grow its footprint. In Chile we look forward to seeing the government's final policy.

We have a contract with CORFO that lasts until 2043 and will thus be in the country for the long term. There are several important conditions that we agreed with CORFO in 2016, one of which is that we pay the highest royalty or commission for lithium production in the world, which goes up to 40% of the final sale price of the product. We will contribute approximately US\$300 million in R&D funding to CORFO between 2016 and 2043, which has contributed to CORFO funding a center of E-mobility and a circular economy center in northern Chile. We also contribute 3.5% of our sales to indigenous communities.

Production growth must be achieved in a sustainable way, and Albemarle is committed to reaching carbon neutrality by 2050. We have started a journey with IRMA (the Initiative for Responsible Mining Assurance); we are actually the first mining site in Chile and the first lithium site in the world to start the self-evaluation process, and in April 2022 we finalized the third party audit at our Salar plant. ■

Precious Metals

Chile's untapped potential in the gold sector



Image courtesy of Kinross

Despite its geological endowment, Chile is not known for its gold mining. It was the 27th ranked producer in 2020, according to figures from the World Gold Council, behind Venezuela, Argentina, Colombia, Peru, Mexico and Brazil. Furthermore, although large producers including Gold Fields, Yanama Gold and Kinross are active in the country, Chile lacks producing gold assets on the level of Newmont's Yanacocha in Peru or Barrick's Veladero in Argentina. However, there is no shortage of potential to raise the production profile of Chile's precious metals segment as a number of interesting development projects are in the works.

The standout precious metals development project in Chile's pipeline is Gold Fields' Salares Norte. Currently under construction, with production expected to start in 2023, Salares Norte has an 11.5 year life of mine with a production average of 350,000 oz/y of gold, including 450,000 oz/y for the first seven years, which would make the project Chile's most prolific gold mine from an annual production standpoint by some distance.

On May 31st, 2022, the news that Gold Fields had entered into an agreement to acquire Yamana Gold in a deal worth US\$6.7 billion means that the new entity, which will become the world's fourth biggest gold producer, will add Yamana's El Peñón and Minera Florida operations to its Chilean portfolio.

Another greenfield asset currently under construction is Rio2's Fenix gold project, which is expected to achieve its first gold pour in 2023, according to president and CEO, Alex Black. Black mentioned that the characteristics of Fenix are very similar to the two mines

that the Rio2 management team built in Peru – La Arena and Shahuindo – under its previous company Rio Alto Mining, which was acquired by Tahoe Resources for C\$1.2 billion in 2015. Fenix lends itself to simple gold heap leach ADR operations where material does not have to be crushed and therefore does not require large capex to build. Black added: "When you talk about inflation, a 10% increase on a US\$120 million build is a lot more manageable than on a US\$1 billion project. From our experience, we know we can move things around to save costs in different areas."

In July 2022, Rio2 Limited's EIA was rejected on the recommendation of Chile's environmental agency (the SEA), which stated that more studies are needed to assess the impact of the project on three types of fauna. In a decision that appears political in its motives, considering that Rio2 had performed extensive environmental studies and ticked all the boxes required, the decision should be concerning for everyone involved in Chile's mining sector.

Following the decision, Rio2 released a statement that the Company will work on evaluating its options and decide on an action plan. Once the action plan is completed, the company will announce how it intends to execute it and provide the revised timeline.

One of the things that makes the Fenix Gold project attractive is its low capital intensity, something which was highlighted by Randy Smallwood, president and CEO of Wheaton Precious Metals (WPM), who helped finance the construction of Rio2's Fenix via a US\$50 million gold streaming agreement. "We have seen so many

examples in the mining industry where people are too aggressive in terms of their first buildout, and this is particularly relevant in an era of supply chain delays and rising inflation," observed Smallwood, mentioning that he particularly liked Rio2's strategy of opting for a staged approach to grow the mine, adding that Alex Black's track record of delivering high quality projects on time and on budget also influenced WPM's investment decision.

On the brownfield side, Kinross announced that on February 1, 2022, its La Coipa processing plant (located near Rio2's Fenix Gold project) had restarted operations. The restart comes after a year of mechanical maintenance, rehabilitation of electrical systems and instrumentation, and restitution of equipment that had been preserved since 2013 after a Partial Temporary Stoppage (PTP) for eight years, according to Rolando Cubillos, vice president and general manager of Kinross Chile.

Cubillos listed the pending items to optimize the Phase 7 mine plan at La Coipa: "Plant renovations are currently focused on the crushing, grinding, leach pads, refinery, filtration and tailings areas, making sure critical components are complete to start first-stage production and move towards full operating capacity by the middle of 2022."

On March 12th, 2022, Kinross announced it had poured its first gold bar at La Coipa, and the company is eyeing expansion at the nearby Lobo-Marte project, located about 50 km from the main pit, after the conclusion of mining at Phase 7.

Looking further forward, exploration, development and consolidation in the southern Maricunga belt in the area surrounding Norte Abierto, the Barrick/Newmont JV comprised of the Caspiche and Cerro Casale gold-copper porphyry deposits offers the potential for a large-scale operation. While a Supreme Court order to redo an EIS has stalled progress, Barrick's president and CEO, Mark Bristow, has been outspoken on his intention to grow organically through exploration, with the Pascua-Lama and Norte Abierto deposits in Chile included in these plans. ■



Alex Black

President & CEO
RIO2 LIMITED

Can you briefly introduce Rio2 and the company's Fenix Gold project?

Rio2 was established as a private company in 2016, before listing in 2017. In 2017, we came across a company named Atacama Pacific, and completed a merger with them in mid-2018, which gave us ownership of the Cerro Maricunga project, which we renamed Fenix Gold. Fenix Gold is the largest undeveloped gold heap leach project in the Americas, and is now fully financed to production. The technical characteristics of Fenix Gold are very similar to the two mines which the Rio2 management team built in Peru – La Arena and Shahuindo – under our previous company, Rio Alto Mining, which was acquired by Tahoe Resources for C\$1.2 billion in 2015.

Can you tell us about Rio2's industrial water supply agreement with Nueva Atacama, and how you intend to source water economically and sustainably as the project grows?

We are starting the project at 20,000 tonnes per day (tpd) of ore to pad, which requires about 25 liters of

water per second for the leach process. Water will be brought to the mine in tankers from Copiapó, from retreated water supplied by Nueva Atacama. The trucking of water has enabled us to fast-track the project development, and we have had no pushback on trucking water during the EIA process.

Fenix Gold already contains 5 million ounces (Moz) distributed amongst 410 million tonnes of ore, but we believe this could grow through exploration to closer to 10 Moz. As the mine ramps up to produce 250,000+ oz of gold per year, optimal production should be in the region of 80,000 to 100,000 tpd, to really turn Fenix Gold into a world-class gold mine. There are a number of desalination projects, such as ENAPAC, which is building a desal plant in Copiapó and looking for clients plus some subsurface water options which we are investigating. In the not too distant future we hope to show where we are going with our longer term water strategy, but the priority now is to get the mine into production. ■



Rolando Cubillos

Vice-President & General Manager
KINROSS CHILE

Can you provide an overview of Kinross' La Coipa, Lobo Marte and Maricunga operations in Chile?

La Coipa has now begun to take firm steps towards reopening with the exploration of the Phase 7 deposit after a Partial Temporary Stoppage (PTP) for eight years. Meanwhile, Lobo Marte, a gold deposit at an height of 4,200 m, will be responsible for providing operational continuity to Kinross in Chile. Finally, Maricunga has been in the PTP stage since 2016, and this project continues to comply with the environmental obligations contracted in its Environmental Qualification Resolutions.

Which refurbishments are being made at La Coipa?

On February 1, 2022, the La Coipa process plant restarted its operations after a year of mechanical maintenance, rehabilitation of electrical systems and instrumentation.

In November 2021, the mine operations area inaugurated the mining road to connect the Phase 7 pit with the primary crusher of the 15,000 t/d plant.

Plant renovations are currently focused on the crushing, grinding, leach pads, refinery, filtration and tailings areas, making sure critical components are complete to start first-stage production and move towards full operating capacity by the middle of 2022.

What were the highlights from the feasibility study published for the Lobo Marte project?

Special emphasis has been given to the incorporation of environmental and community considerations as part of the project design, which has had the constant participation of the various stakeholders. The purpose is to adapt to the local environment, protecting water resources and biodiversity in general.

According to the FS, the project schedule will be linearly linked to the end of La Coipa, providing greater flexibility for its start-up, which could take place towards the end of this decade. Meanwhile, Kinross continues to work on activities aimed at obtaining permits and the EIA. This project is expected to extract 4.7 million oz Au over a mine life of 16 years. ■



“We would like exploration to open the door to new developments, so we aim to make the necessary regulatory changes to increase legal certainty for those who are willing to invest in exploration.”

**-Marcela Hernando,
Minister of Mining,
Government of Chile**

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Image courtesy of Atex Resources

Study-stage copper projects

Hunting for scale and a near-term path to production

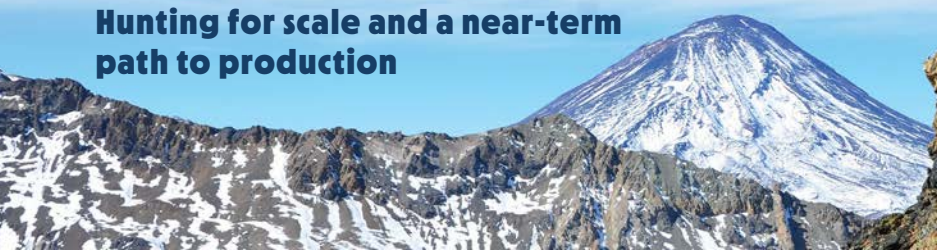


Image courtesy of World Copper Ltd.

The world is hungry for copper and its appetite looks set to increase. A February 2022 report from Bank of America global research analysts forecast that the copper market will flip back to a deficit from 2025 onwards following the completion of the current wave of project buildouts. Vanessa Davidson, head of copper research at CRU, also sees a supply gap from 2025, with the majority of demand set to come from outside China, particularly in Southeast Asia and India, but also North America and Europe as green technologies and the transition to electric vehicles really start to take off.

Even in the near term, sluggish financial markets in May 2022 and widespread lockdowns in Chile failed to significantly dim copper's shine, as the price of the red metal hovered around the US\$4.00/lb mark after reaching record highs in early March. In addition to the expected supply gap and future demand being baked into the price, one

of the reasons for copper's performance has been the lack of exploration success in recent years and the lengthy timeline to move projects into production.

Two of the standout junior success stories of the last two years have been South American copper plays. In 2021, Solaris Resources' market cap reached C\$1.5 billion as it continues to advance its Warintza project in Ecuador. In May 2022, Filo Mining's market cap rose above the C\$3 billion mark on the back of remarkable drilling results at its Filo del Sol high-sulphidation epithermal copper-gold-silver deposit on the border of Argentina's San Juan province and Chile's Maricunga belt, showing grade and scale indicative of a major mine.

Speaking at the World Copper Conference in Santiago, Ragnar Udd, BHP's president of minerals – Americas, cited the company's recent C\$100 million investment in Filo Mining as the type of early-stage entry that BHP is willing to

make to grow its copper pipeline. However, the pertinent point about assets such as Filo del Sol and the reason they hold such a premium is their scarcity.

"There is a huge amount of appetite for exposure to copper but the playing field of potential companies for the market to talk to is small. Investors cannot find many projects that have a short timeline to production as well as the ability to be financed without partnering with a major mining company," reflected Hayden Locke, president and CEO of Marimaca Copper (TSX: MARI).

Marimaca is currently advancing its namesake copper oxide project near Antofagasta with a heap leach SX/EW approach that means it does not need to desalinate water and will be able to process a refined grade A copper cathode, lowering project capex and putting Marimaca in the first quartile of global copper mine site emissions intensity.

Due to the company's exploration success in 2021, management has had to adapt timelines to what it believes is likely a materially larger deposit, according to Locke.

"The original depth of the Marimaca oxide deposit (MOD) was approximately 250 m to 300 m, but the MAMIX drilling has potentially more than doubled the depth of the project, with leachable material at the bottom of the open pit," detailed Locke, adding that it is an obvious focus to get into a resource that the company can then use in the DFS, which is expected in the second half of 2022. "This will allow us to both increase the scale of the project in terms of copper production and also the life of mine."



There is a huge amount of appetite for exposure to copper but the playing field of potential companies for the market to talk to is small. Investors cannot find many projects which have a short timeline to production as well as the ability to be financed without partnering with a major mining company.

**- Hayden Locke,
President & CEO,
Marimaca Copper**



Another of Chile's advanced juniors is Hot Chili (TSXV: HCH), which reported a resource upgrade for its Costa Fuego copper-gold project headlined by a 67% increase in the total indicated resource and a 53% increase in the high grade indicated resource. Costa Fuego comprises the Cortadera, Productora and San Antonio deposits, all of which have updated mineral resource estimates and are close to one another at low-altitude elevations, 600 km north of Santiago. The updated resource totals 927 million tonnes @0.45 Cu Eq, but drill results released in April including 248 m at 0.8% Cu Eq at Cuerpo 3 suggests the potential for higher grade mineralization.

"This month (May 2022) we will start drilling out and expanding the high grade satellites of both Valentina and San Antonio where we just recently announced a maiden 4.2million t inferred open pit resource grading 1.2% Cu Eq," said Christian Easterday, Hot Chili's managing director, noting that access to a number of high-grade sources allows the company to design a project with short payback periods.

Hot Chili intends to deliver a combined PFS later in 2022 before project financing kicks off in Q1 2023. A bankable feasibility study is expected to be complete by the end of 2024, before a two-year construction timeline with first production in early 2027. From a corporate development standpoint, the company appointed Nicole Adshedd-Bell to its board of directors in March 2022, who brings over 25 years of capital markets experience, and in the same month an offtake agreement with Glencore was announced for 60% of copper concentrate from Costa Fuego for eight years from start of commercial production.

One of the newer study-stage juniors active in Chile is World Copper (TSXV: WCU), which listed in January 2021 and owns the Escalones and Cristal projects in Chile, as well as the Zonia project in Arizona. The company released a PEA for Escalones in February 2022 showing a US\$1.5 billion post-tax NPV and a 46.2% IRR at a US\$3.60/lb copper price, with a payback of 2.18 years. Escalones is an SX-EW oxide heap leach operation,

located 97 km southeast of Santiago and 35 km east of El Teniente, with an estimated US\$438.4 million capex from construction decision.

Nolan Peterson, World Copper's CEO, remarked that the resource included in the PEA for Escalones is only half of what the company believes to be the overall resource. He elaborated: "The other half has seen no historical drilling, but geologically it is clear that it is an extension of the main resource. There is also deep sulphide potential as well as three other copper porphyry skarn targets to the north-east that have never been drilled."

Marcelo Awad, World Copper's executive director, explained that most of the companies that held Escalones in the past were drilling very deep in search of a sulfide deposit, without paying sufficient attention to the oxide layer. He discussed the company's exploration targets for 2022: "We also discovered an area of yellow color, our primary target called Mancha Amarilla, which we believe to be part of the

main oxide deposit that has tremendous potential."

Although Chilean mining is best known for its large operations, some companies prefer quicker start-ups that can fund exploration and development through the cash flow generated from small-scale production. Altiplano Metals (TSXV: APN), for example, runs the Falleron 5,000 t/month IOCG-operation located near La Serena, and is currently finalizing construction of its El Peñón processing facility (as of May 2022). The proceeds from this production are used to help fund activities such as underground development at the company's Maria Luisa project and exploration and its Pastillas project in the Maricunga gold belt.

Alastair McIntyre, Altiplano's president and CEO, spoke of the benefits of this business model: "Unlike most juniors, our focus on cashflow is to enhance understanding of our assets to catalyze further growth and this is a model that investors like." ■

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Can you briefly introduce World Copper and explain how the company was established?

World Copper is Canadian junior based out of Vancouver, which started trading on the TSXV in January 2021. We own the Escalones and Cristal projects in Chile, and the Zonia project in Arizona. Prior to listing, we were a subsidiary of Wealth Minerals where our chairman and founder, Henk van Alphen, is the CEO and chairman. Through Wealth Minerals, Mr. Alphen connected with Marcelo Awad, previous CEO of Antofagasta, and after seeing potential in the Escalones property, they founded World Copper to further advance the asset. We have recently transitioned from exploration to early stage development and have an exciting runway ahead of us.

Can you elaborate on the PEA for the Escalones project and the type of operation it shows?

Escalones is an SX-EW oxide heap leach operation and is the largest oxide copper deposit in exploration and development in Chile at this time. The initial capital is extremely low at US\$438.4 million from construction decision. This has led to very impressive economics of approximately US\$1.5 billion post-tax NPV and a 46.2% IRR at a US\$3.60/lb copper price, with a payback of 2.18 years.

Can you explain what makes the LOM head grade of 0.38% Cu economic?

Looking at four oxide heap leach mines in Chile that are held by majors – Los Bronces, Gabriela Mistral, Lomas Bayas, and Zaldivar – their grades are in many cases lower than the 0.38% at Escalones. An oxide heap leach operation is considerably more viable for production as the economics are more attractive.

The PEA assumes water being available from the Rio Pangal Valley near El Teniente. Considering the issue of water scarcity in Chile, how are you preparing for this?

El Teniente is the world's largest underground mine, and they draw water from the Rio Pangal Valley. We have



Nolan Peterson

CEO
WORLD COPPER LTD.



We have recently transitioned from exploration to early stage development and have an exciting runway ahead of us.



envisioned building a pipeline into the Rio Pangal Valley under the assumption that our SX-EW operation would use approximately four times less water per pound of copper produced than the El Teniente operation. That being said, El Teniente is planning to build a pipeline from the coast to their project, and we are in discussions with them to come to an agreement where we can tie into that pipeline, giving us further access to water.

What access to infrastructure does the Escalones project have?

Escalones is 97 km southeast of Santiago and 35 km east of El Teniente, and there is a 60 km gravel road to the nearest community. The site is owned and well maintained by a local gas company, and we already have all the agreements and concessions to allow us to develop the mine. We have power access as there are many hydroelectric dams in the region that we can tie our grid access into. Furthermore, Escalones is at a relatively low elevation compared to other copper projects in the region.

What are the next steps to advance the project through exploration and development?

As fantastic as the economics are, Es-

calones has significant upside exploration potential. The resource we put in the PEA is only what we believe to be half of the overall resource. The other half has seen no historical drilling, but geologically it is clear that it is an extension of the main resource. There is also deep sulphide potential as well as three other copper porphyry skarn targets to the northeast that have never been drilled.

We have applied for permits that will allow us to conduct a 5,000 m drill program at the Mancha Amarilla lithocap that extends 1 km south from the main Escalones deposit. This will give us an indication if the resource is twice the size indicated in the PEA and will allow for more flexibility in our development options. We will then conduct footprint drilling on the northern Rio Negro target.

Starting 2023, we have envisioned a more detailed drill program that will allow us to upgrade the resource and prepare for a PFS and FS. Along the way we will be permitting, acquiring baseline information, and building community relationships. Currently, we are envisioning starting construction in approximately five years with mining operations starting two years after that. This is too perfect an asset to rush. ■

What discussions have you had with the new government regarding lithium regulations that would accelerate the development of Wealth Minerals' Atacama Salar and Ollague assets?

We have made contact to meet with Chile's new mining minister, Marcela Hernando, who I met while I was CEO of Antofagasta PLC and she was the mayor of Antofagasta, and also later as a member of congress. I was very pleased when I heard her name as minister, because as well as being mayor of Chile's biggest mining region, she chaired a mining committee in the lower house of congress for over three years. In other words, she has a lot of experience and knowledge about the industry. Importantly, she is very open and in previous interactions has always listened to the concerns of the mining sector.

The new president and mining minister have both been clear with the message that Chile has to develop its lithium business. We know that the window to develop lithium assets is now and perhaps for the next 10 to 15 years, because the substitutions are already at lab level. One thing they have highlighted is the importance of adding value to lithium production in Chile by developing downstream elements in the country. This would be, most likely, in the form of battery components rather than full-scale battery assembly.

President Boric has spoken about creating a national lithium company. What could this mean for the private sector involved in Chile's lithium industry?

Since he was elected president and named his cabinet, Boric has been clear that if a state-owned lithium company were to be created, it would assist private producers rather than replace them. The State understands that it needs revenue generated by mining to use elsewhere in the economy, and therefore is unlikely to do anything radical which would jeopardise that source of income. The main risk we see is the Constitutional Convention Committee, which proposed a draft to nationalize all mining companies in Chile.



Marcelo Awad

Executive Director
WEALTH MINERALS



Just by developing known reserves, even without exploration success, Chile can increase its copper production by around 2 million t/y and its lithium production by around 1 million t/y.



Although we do not believe such a proposal will pass, it creates unfortunate noise in the short term.

How do you view the fundamentals of lithium for 2022 and 2023?

I believe demand will outweigh supply until around 2030. There is sufficient lithium in the world, but the challenge is to achieve a battery-grade product economically. Even though prices have risen dramatically in 2021 and Q1 2022, I see a longer-term price stabilizing around US\$15,000 to US\$20,000 per tonne. This is comfortable for the likes of SQM and Albemarle that are mining the Atacama Salar, but will be a challenge for many hard rock or clay deposits elsewhere.

What potential do you see in the World Copper's Escalones project?

Most of the companies that held Escalones in the past were drilling very deep in search of a sulfide deposit, without paying sufficient attention to the oxide layer. Sulfide deposits, particularly in high-altitude, arid parts of the country, require huge output and capex to justify investment. We acquired the asset and span out a separate company because we are very excited about the oxide layer, and started a drilling campaign in March

2022 to explore this further. We also discovered an area of yellow color, our primary target called Mancha Amarilla, which we believe to be part of the main oxide deposit that has tremendous potential.

World Copper's aim is to access around 52,000 t/y of oxide copper production for the first 10 years of the project, which will help access the sulfide layer more easily in the future. In other words, we will be monetizing the stripping process, which is often a big expense when it comes to moving waste.

Where would you like to see the Chilean mining industry by 2023?

The most important thing is to bring back full stability for investors. Just by developing known reserves, even without exploration success, Chile can increase its copper production by around 2 million t/y and its lithium production by around 1 million t/y. There are a number of inactive oxide plants in Chile that could be used to bring new projects into production. The revenue from this production would generate vast wealth for Chile that would dwarf extra taxes being discussed on current mines, in addition to creating thousands of jobs and indirect benefits for millions of Chileans. ■



Hayden Locke

President & CEO
MARIMACA COPPER

How is the company working towards a definitive feasibility study (DFS) for the Marimaca project?

We are currently drilling to expand the resource at Marimaca and move the inferred resource into the measured and indicated category, with the view to do a DFS in the second half 2022. Marimaca as it currently stands is a decent mid-sized project, but through exploration we see the opportunity to become one of the most important copper development projects globally, with a relatively short timeline to development.

Can you tell us about the Marimaca Oxide Deposit (MOD) depth extension (MAMIX) drilling program?

We are moving the project forward while continuing to explore. We had intended to start engineering until we made the game changing MAMIX discovery, below the MOD. The MAMIX drilling has potentially more than doubled the depth of the project. It is an obvious focus for us to get this into a resource that we can then use in the DFS. This will allow us to both increase the scale of the project, in terms of copper production, and also the life of mine.

We are positioning Marimaca extremely well for what might be coming in the future such as carbon taxes and more onerous financing criteria from investors with regard to ESG. ■



Christian Easterday

Managing Director
HOT CHILI LIMITED

Can you elaborate on the progress Hot Chili made at the Costa Fuego project?

The last three years have been transformational. We have quadrupled our resource base and positioned the company for production at Costa Fuego by late 2026. In March 2022 we released a resource upgrade. We raised funds of approximately A\$110 million in 2021 to buy 100% of the Cortadera porphyry discovery, as well as completing an additional 52,000 m of drilling. Over 81% of the resource at Costa Fuego is now in indicated classification. High grade indicated resources represent one third of Costa Fuego's Indicated resource base, currently standing at 156 million t grading 0.79% CuEq for 1 million t copper, 0.85 million oz gold, 2.9 million oz silver and 24,000 t molybdenum.

Our pre-feasibility for Costa Fuego is studying a multi-decade open pit and underground project which will produce approximately 100,000 t/y of copper and around 60,000 to 80,000 oz/y of gold.

Over a decade of permitting and resource growth has positioned Hot Chili with one of the most advanced senior copper developments in the America's, with one of the lowest economic hurdles owing to its low-altitude location and infrastructure advantages. Everything is being prepared to transition through development and into financing and construction. ■



Alastair McIntyre

President & CEO
ALTIPLANO METALS

What were the main milestones achieved by Altiplano Metals in 2021?

Altiplano Metals is a growth-focused mining company with a two-pronged approach that involves generating cash from producing assets which can be used to develop existing projects, acquiring projects, purchasing equipment, and funding exploration assets. This approach provides investors positive cash flow and exploration upside.

Despite the challenges brought by Covid, 2021 was a productive year for our team in Chile. We had several milestones including expanding our underground operations and completing an underground drill program at Farellon, beginning construction of our copper-gold and iron processing facility at El Peñón, and beginning an underground development program at Maria Luisa – a historical gold-copper project.

Additionally, we acquired an exploration asset in the Maricunga region, one of Chile's most identifiable gold camps. Pastillas is near several world-class gold mines including La Coipa and Rio2's Fenix project. Our next goal is to add near cash-flowing assets and district scale discovery potential exploration projects to complement our existing projects.

What are your views on the market for 2022?

Investors are looking for growth story companies and with stronger metals prices the capital markets become much more supportive for mining companies like Altiplano Metals. ■

Early-stage opportunities

The potential for big returns in copper-gold porphyry exploration



Image courtesy of Pampa Metals

For investors with a bigger risk tolerance and those hunting for the elusive multi-baggers, the early-stage end of the junior market is where the best returns can be found. These companies are also the lifeblood of an industry in dire need of new discoveries, particularly after a period where majors have preferred to extend brownfield operations rather than allocate budget for greenfield exploration.

"The biggest value-add moment for investors is the transition from exploration to discovery," stated Timothy Beale, director of Pampa Metals (CSE: PM), the Canadian junior with a portfolio of eight projects in northern Chile, with a focus on porphyry copper gold targets. "There are not many junior companies like us currently doing grassroots exploration," he added.

Austral Gold, Pampa's JV partner at its Morros Blancos and Cerro Blanco projects, started its first drill test at Morros Blancos in January 2022 and drilled four diamond core holes totaling about 1,400 m at the Rosario del Alto high-sulphidation gold-silver target. They intend to drill more holes hopefully later this year. At its Cerro Buenos Aires target, Pampa discovered a completely new zone of porphyry-related, quartz-vein stockwork at surface at its Block 4 project and started trenching towards the end of 2021. "The results from this program, and more recently the results from an IP geophysical program, have shown the newly named Buenavista Target at Block 4 to be a high priority drill target."

Pampa Metals also has an option to evaluate and explore a series of copper and precious metals targets on eight new property blocks totaling approximately 18,700 hectares in the Paleocene mineral belt of northern Chile, which are owned by VerAI Discoveries. The agreement grants Pampa the right to explore VerAI's properties with an exclusivity period of up to 12 months, with an investment of US\$500,000. If Pampa selects a block as a designated project for development, it has the option to acquire 51% of the project, subject to a further exploration investment of US\$1 million over two years, and 75% by completing an NI-43-101 compliant PEA over the following two years.

Yair Frastai, CEO and co-founder of VerAI, describes the company as "a disruptive AI-based mineral asset generator that changes how the world discovers mineral deposits." VerAI was formed in 2020 to tackle the biggest challenge of mineral exploration – finding concealed mineral deposits under covered terrain. "As vast areas of the mining countries are

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completely covered, the conventional exploration model is not effective, not economically viable, and not scalable," said Frastai, illustrated by today's success rate of less than 1 in 1,000 exploration deposits becoming a mine.

Most exploration companies look only for proxies or conditions for a mineral deposit, such as favorable host rocks, structures, and alterations. "VerAI, on the other hand, deploys a novel proprietary AI technology, utilizing tailor-made datasets and an exclusive catalog of patterns from existing economic ore bodies in order to identify, with a high level of probability, the location of new economically viable mineral deposits," explained Frastai, adding that the company's AI-based discovery platform successfully targets concealed deposits of various commodities, including Cu, Mo, Zn, Au, Co, and Ni in various geological jurisdictions. "We believe that the next significant economic discoveries will be in the underexplored covered terrain, which is where we are focusing our technology and innovation efforts."



The cycle of mining leads to the discovery of the obvious stuff first, and then one shifts to the second and third tier opportunities. Nevertheless, yesterday's second and third tier opportunities are often today's first tier opportunities. Low sulphidation epithermal (LSE) systems do not express well at surface. For example, before El Peñón was discovered, it was a very plain looking piece of ground and there was nothing visible at surface other than what looked like some ordinary boulder fields.



**- Brian Miller,
CEO,
Astra Exploration**



When asked about the future of the gold industry, Tom Palmer, president and CEO of Newmont, pointed to the importance of deposits that contain both copper and gold: "When it comes to decarbonization, as gold operations

are developed you will see more copper-gold mines coming online, such as Yanacocha."

High-sulphidation oxide gold deposits with a large copper porphyry layer underneath are a feature of Andean geology and can host the scale to attract major companies. ATEX Resources (TSXV: ATX) was formed in 2019 and immediately acquired its flagship Valeriano copper gold project, which is located in a new emerging belt, the Link Belt, between the famous Maricunga and El Indio districts. Raymond Jannas, president and CEO, explained that from historic results and ATEX's exploration work and complete relogging of all the drill holes, the company believes that Valeriano has many similarities to Filo Mining's Filo del Sol project. He elaborated: "Both have high sulphidation copper mineralization progressing in depth into hypogene porphyry mineralization hosted in Permo-Triassic rhyolites as the host rock."

The company also has significant backing. Craig Nelson, ATEX's chairman, previously established Metallica Resources with Pierre Lassonde, who was the lead investor in a private placement that raised C\$8.5 million for ATEX in December 2021. ATEX's share price rose from C\$0.10 in October 2021 to C\$0.85 in April 2022 as the market reacted positively to strong exploration holes that have started to demonstrate the makings of a significant deposit.



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Looking to the year ahead, Nelsen said: "As a result, we would like to see all outstanding warrants exercised and go to market to raise approximately C\$25 to 50 million to further advance the project."

Torq Resources (TSXV: TORQ) has a portfolio of three projects in Chile, consisting of the Margarita IOCG and Andrea copper porphyry assets, as well as the Santa Cecilia project, which was acquired in November 2021. Santa Cecilia is located approximately 100 km east of Copiapó, in the southern region of the Maricunga belt, immediately adjacent to the Norte Abierto project which comprises of the Caspiche and Cerro Casale gold-copper porphyry deposits, collectively containing proven and probable reserves of 23.2 million oz Au and 5.8 billion lbs of copper. "Results from two historical drill holes and additional surface and geophysical work support the logic that the project has a similar mineral system to Norte Abierto, and we believe we can make a discovery that will be attrac-

tive to a major mining company," said Shawn Wallace, Torq's executive chair.

The real potential that Torq is trying to unearth is whether Santa Cecilia, sandwiched between two major projects that are currently suspended, can tip the economic scale for the entire complex. "There are technical attributes to the project which suggest this could be the case," stated Wallace, explaining that on top of the porphyry system discovered through the two historic drill holes there is an oxide gold cap that was uncovered through a small drill program by a major mining company in the late eighties. He added: "Our next steps are to drill off the porphyry to establish economic viability, while also outlining the potential of the gold system on top. We also believe there is another potential porphyry on the boundary between Caspiche and Santa Cecilia, and we will identify targets to make this discovery."

In May 2022, Torq announced a new discovery at its Margarita IOCG of 90 m of 0.94% Cu and 0.84 g/t Au. Wallace

described the discovery drill hole as "a remarkable success for Torq," before affirming that the team is now preparing for a follow-up drill program. He added: "while our exploration success at Margarita is significant and we look forward to expanding upon our new discovery, Torq is also highly focused on its Santa Cecilia gold-copper project in the Maricunga belt."

Astra Exploration (TSXV: ASTR) was formed in August 2020 and listed in January 2022, and predicated on the exploration opportunity and potential for discovery of precious metals deposits in northern Chile. "This region is synonymous with copper exploration, but much less so for precious metals," commented Brian Miller, CEO.

Discussing Astra's Pampa Paciencia project, Miller suggested that, based on exploration results, the company believes there to be a large epithermal system just under cover, and drew the comparison of notable low sulphidation systems such as in El Peñón, located 175 km to the south. ■



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What attracted you to establish ATEX Resources and acquire the Valeriano copper gold project?

RJ: In 2010, when I was VP of geology and exploration at Hochschild, the company optioned the property as we were interested in the high sulphidation epithermal (HSE) gold system and believed that there could be a porphyry at depth. During two drilling campaigns, Hochschild encountered HSE mineralization and made the copper-gold porphyry discovery, but had other priorities at the time.

In 2019, ATEX was formed and immediately acquired Valeriano and, in 2020, staked several HS-Generative projects in Northern Chile. The company divested of all but two of its HS-Gen assets in 2021 to focus attention on our flagship Valeriano property. We believe that Valeriano has many similarities to Filo Mining's Filo del Sol project. Both have high sulphidation copper mineralization progressing in depth into hypogene porphyry mineralization hosted in Permo-Triassic rhyolites as the host rock.

How have you advanced the Valeriano property through exploration?

RJ: After acquiring the project in 2019, we started working on putting out inferred resource estimates for both the near-surface HSE gold oxide deposit and the copper-gold porphyry deposit. The results outlined an HSE deposit containing 585,000 oz gold and 2.65 million oz silver in the inferred category, totaling 622,00 gold equivalent (Au eq.) oz at an Au eq. grade of 0.561 g/t. The copper-gold porphyry deposit contains an estimated 1.77 million t of copper, 1.84 million oz Au and 8.62 million oz Ag in the inferred category, for a combined 2.30 million t of Cu eq.

We proceeded to raise approximately C\$3 million in late 2020 and, in early 2021, commenced with a drilling program focused on expanding the size of the HSE gold oxide deposit as well as converting inferred resources to the measured and indicated categories. Although the HSE gold deposit is an interesting resource, we decided the real value in the property is the copper porphyry at depth and



RJ



CN

Raymond Jannas & Craig Nelsen

RJ: President & CEO, CN: Chairman
ATEX RESOURCES

built a conceptual model of what the porphyry system could look like, followed by a C\$8.5 million financing round to further drill the deposit. This Phase II campaign commenced in January 2022 looking for porphyry extensions of the known high-grade zones, drilling two holes, one 200 m northeast and the other 200 m southwest of our best intersections.

ATEX raised C\$8.5 million through a private placement in December 2021. What led to the company's share price appreciation before this financing and where will these funds be focused in 2022?

CN: During and after the financing, ATEX's share price increase almost five times, going from C\$0.10 in October 2021 to C\$0.48 in December. Getting Pierre Lassonde on board as a lead investor in a private placement attracted significant attention.

RJ: All the funds raised went into the advancement of the Valeriano project. Phase II drilling focused on extensions of the known high-grade mineralization zone defined by drill hole VALDD-14 (1,194 m with 0.52% Cu, 0.24 g/t Au, 1.0 g/t Ag & 36.4 ppm Mo for a 0.73% Cu-equivalent). ATXD-17, located 200 m southwest of VALDD-14 is the first hole drilled by

ATEX to test copper gold porphyry mineralization which returned 1,160 metres grading 0.78% copper equivalent (0.53% Cu, 0.28 g/t Au and 70 ppm Mo) including 550 m of 1.03% CuEq (0.69% Cu, 0.39 g/t Au and 70 ppm Mo). ATXD-19, located 200 m northeast of VALDD-14, was lost short of its target, however, returned 647 m of 0.65% CuEq (0.50% Cu, 0.15 g/t Au & 60 ppm Mo) ending in strong porphyry mineralization. The drill results represent a major expansion of the porphyry mineralization outlining an 850 by 800 m envelope of copper gold mineralization with a +0.4% CuEq vertical extent of over 1 km indicated by multiple drill holes, which remains open. However, we will need another 50 to 70 drill holes to come out with an adequate indicated resource.

Where would you like to see the company by 2023?

CN: We would like to see all outstanding warrants exercised and go to market to raise approximately C\$25 to 50 million to further advance the project. Concurrently, we will continue expanding our team to set us on the path of doing everything right, focusing on the community, government relations and environmental aspects of developing the project. ■

What have been the main milestones achieved by Torq Resources in the last 12 months?

Approximately a year ago, Torq Resources acquired the Margarita IOCG and Andrea copper porphyry projects, which were our entry projects into Chile. However, the main reason we entered the country was for the prospect of acquiring the Santa Cecilia gold-copper project, which we were able to do in November 2021. While we expect Santa Cecilia to become Torq's flagship asset, we also see great potential in Margarita and Andrea, and commenced a drilling program at Margarita project in October 2021.

What potential do you see in the Santa Cecilia gold-copper project in the Maricunga Belt?

Santa Cecilia is located approximately 100 km east of Copiapó, in the southern region of the world-class Maricunga belt, and is immediately adjacent to the Norte Abierto project, which is owned jointly by Newmont and Barrick. Norte Abierto is comprised of the Caspiche and Cerro Casale gold-copper porphyry deposits, collectively containing proven and probable reserves of 23.2 million oz of gold and 5.8 billion pounds of copper. At Santa Cecilia results from two historical drill holes and additional surface and geophysical work support the logic that the project has a similar mineral system to Norte Abierto, and we believe we can make a discovery that will be attractive to a major mining company. The real potential we are trying to unearth is – can Santa Cecilia, sandwiched between two major deposits which are currently suspended, tip the economic scale for the entire complex?

There are technical attributes on the project which suggest this could be the case. On top of the porphyry system discovered through the two historical drill holes, there is an oxide gold cap, which was uncovered through a small drill program by a major mining company in the late eighties. Our next steps are to drill off the porphyry to establish economic viability, while also outlining the potential of the gold system on top. We also believe there is another potential porphyry on the boundary between



Shawn Wallace

Executive Chair
TORQ RESOURCES



The real potential we are trying to unearth is – can Santa Cecilia, sandwiched between two major deposits which are currently suspended, tip the economic scale for the entire complex?



Caspiche and Santa Cecilia, and will identify targets to make this discovery.

How do you intend to advance the Margarita IOCG project and Andrea copper porphyry project?

Through our drill program at Margarita, we have established that oxide copper is prevalent all over the the project. As we are still at the prospecting stage at Margarita, we used RC (Reverse Circulation) drilling as it is much less expensive than core drilling, because the priority is to identify the copper sulphide source of oxide copper before we define further drill targets. We are currently waiting on assay results before deciding how to advance.

We have only done a small amount of work at Torq's Andrea project, as our plans were somewhat deferred when we acquired Santa Cecilia. We will continue to focus on Santa Cecilia for now, and will explore the potential at Andrea in the future.

How do you view the current market sentiment for investment in copper junior companies?

The electrification of the world is going to continue, and copper will soon run into a serious supply deficit. I believe we will see significant interest and investment into copper moving forward, just

in time for Torq to discover the next big porphyry copper-gold deposit in Chile.

What are Torq Resources' priorities for the rest of 2022?

As Torq only recently acquired the Santa Cecilia project, we are in the process of building relationships with local communities. We are fortunate that the community is familiar with mining as they are already dealing with Barrick and Newmont, and in some ways, they are educating us on how we can work together. We want to establish a working relationship so we can make a discovery that benefits all stakeholders.

Importantly, we aim to put money in the ground as quickly as we can. As a junior, it pays to put money into real exploration work as soon as possible, because all other overhead costs persist, so those who explore slowly get fewer dollars, percentage-wise, into the ground. With this in mind, Torq Resources intends to explore aggressively in 2022.

What type of company would you expect to see move these projects into production?

Our goal is to make meaningful mineral discoveries and we would like to see an experienced mining company take them into development and production. ■

What were the main milestones achieved by Pampa Metals in 2021?

Pampa Metals is still a very young company, being established in December 2020. We conducted extensive geophysical programs over our largely covered porphyry copper targets in Northern Chile, and surveyed several of our projects with a combination of induced polarization (IP) technologies and magnetics. Detailed geological mapping on available outcrops is crucial to our targeting. These surface programs were followed by diamond drilling on two of our projects, which included drilling of three separate targets at our Redondo-Veronica project and one target at our Cerro Buenos Aires project.

Towards the end of 2021, we started doing further detailed geophysical surveying on the Cerro Buenos Aires target. In the meantime, we discovered a completely new zone of porphyry-related, quartz-vein stockwork at surface at our Block 4 project and started trenching towards the end of 2021. The results from this program, and more recently the results from an IP geophysical program, have shown the newly named Buenavista Target at Block 4 to be a high priority drill target.

Although we have not yet made a discovery, our drilling programs at both Redondo-Veronica and Cerro Buenos Aires were very positive, and we believe we have clear line of site towards potential discoveries. The Buenavista Target at Block 4 is very exciting for us. Pampa Metals also signed an option and joint venture agreement with Austral Gold, allowing them to earn in to our Morros Blancos and Cerro Blanco projects.

Can you tell us about Pampa's partnership with VerAI Discoveries?

VerAI's technology is based on high-resolution geophysics, using very specific proprietary algorithms that can successfully be applied to mineral exploration. According to our partnership agreement, Pampa Metals will be allowed to evaluate and explore a series of copper and precious metals targets on eight new property blocks that are owned by VerAI. We have an exclusive option to define one or more designated projects (DP) from the eight property blocks over a 12-month



Timothy Beale

Director
PAMPA METALS



We are encouraging investors to look at the Pampa Metals story, as now is the time to create real value increases for stakeholders by making a major copper discovery along the prime mineral belts of Chile.



period, during which we are required to bear exploration expenditures of US\$500,000. In order to earn a 51% stake in each DP selected, Pampa Metals will spend at least US\$1 million on each DP over the following two years.

We have recently started fieldwork on these properties and have already generated some interesting results.

Pampa Metals is currently active on four copper and gold projects in Chile. Where is exploration work being focused on these projects?

At the Morros Blancos and Cerro Blanco projects, Austral Gold has already progressed surface exploration activities and started their first drill test at Morros Blancos in January 2022. They drilled four diamond core holes totaling about 1,400 m at the Rosario del Alto high-sulphidation gold-silver target. They intend to drill more holes hopefully later this year.

In 2021, Pampa Metals carried out wide-spaced, reconnaissance RC (reverse circulation) drill testing around the relatively small Cerro Chiquitín outcrops at our Cerro Buenos Aires project, which expose portions of a tourmaline breccia body as well as a quartz-veined diorite porphyry complex. This has allowed us to zero down to a much smaller area of interest, which is obscured by post-mineral cover. We completed a

detailed IP survey over this area, which will be followed up with diamond drilling later in 2022. As mentioned, at our Block 4 project, we believe we have delineated a significant drill target for later in 2022.

We are also actively exploring our Block 3 project which, like Block 4, lies along the Domeyko Cordillera copper belt – host to three of the world's top five copper mining districts. We have conducted detailed geological mapping of the available outcrops, and completed drone-flown magnetic surveying, which has delivered a number of interesting potential targets that will be followed up with electrical geophysics and drill testing.

What would you say differentiates Pampa Metals in the copper junior market?

Pampa Metals' main objective is to make discoveries. There are not many junior companies like us currently doing grassroots exploration, and the biggest value-add moment for investors is the transition from exploration to discovery. This is why we are encouraging investors to look at the Pampa Metals story, as now is the time to create real value increases for stakeholders by making a major copper discovery along the prime mineral belts of Chile. ■

Can you tell us about the origins of VerAI Discoveries and your vision for the company?

VerAI is a disruptive AI-based mineral asset generator that changes how the world discovers mineral deposits. We formed VerAI in 2020 to tackle the biggest challenge of mineral exploration – finding concealed mineral deposits under covered terrain. The green energy transition needs enormous quantities of metals, but the low-hanging fruits are already gone, and the mining industry is falling short of discovering new resources to supply the massive demand. As vast areas of the mining countries are completely covered, the conventional exploration model is not effective, not economically viable, and not scalable. Today's success rate of exploration projects is extremely poor, with less than 1 in 1,000 deposits becoming a mine, while in covered terrain the performance is even lower. There is a US\$100 billion opportunity to disrupt the industry by providing high-probability targets in underexplored covered areas. VerAI is not providing a service or selling its technology; instead, we are generating significant value by using our technology to build a portfolio of mineral assets and develop them with partners. We have a very capital-efficient and scalable business model with a broad and diversified portfolio of multiple commodities in various jurisdictions.

What mining, investment and technology experience does the team behind VerAI Discoveries have?

VerAI founders and core team members are rooted in the Israeli Defense Intelligence and Hi-Tech domains. During the last decade, as senior executives in mineral exploration companies in Chile and the US, we have been implementing our knowledge and expertise to significantly improve the success rate of mineral discoveries. We led R&D programs and global field operations of multidisciplinary teams that specialized in innovative solutions to solve complex exploration problems. VerAI's strong Discovery Team is built on the synergy between three essential pillars: data science, geoscience, and commercial expertise – all supported by a tier-one experienced Advisory Team and Board



VF



AA

Vair Frastai & Amitai Axelrod

VF: CEO & Co-Founder & CEO, AA: COO & Co-Founder
VERAI DISCOVERIES

of Directors from the fields of academic research and the mining industry.

How does VerAI Discoveries' Artificial Intelligence (AI) Platform detect concealed mineral deposits?

Most exploration companies look only for proxies or conditions for a mineral deposit, such as favorable host rocks, structures, and alterations. VerAI, on the other hand, deploys a novel proprietary AI technology, utilizing tailor-made datasets and an exclusive catalog of patterns from existing economic ore bodies in order to identify, with a high level of probability, the location of new economically viable mineral deposits. Our AI-based discovery platform successfully targets concealed deposits of various commodities, including Cu, Mo, Zn, Au, Co, and Ni. We believe that the next significant economic discoveries will be in the underexplored covered terrain, which is where we are focusing our technology and innovation efforts.

Can you tell us about your work with Pampa Metals in Chile?

Our partnership with Pampa Metals covers targets across eight property blocks, 100% owned by VerAI and totaling about 18,700 Ha in the Paleocene mineral belt of northern Chile. The Cu, Au and Ag targets identified by our discovery platform are very proximal to

the operating mines of Guanaco and El Penon in the north and the large Casualidad project in the south. The Agreement grants Pampa the right to explore VerAI's properties with an exclusivity period of up to 12 months, with an investment of US\$500,000. If Pampa Metals select a block as a designated project for development, it has the option to acquire 51% of the project, subject to a further exploration investment of US\$1 million over two years, and 75% by completing a NI-43-101 compliant Preliminary Economic Assessment over the following two years.

How do you intend to grow the business in the years ahead?

We already have five portfolios of projects in the pipeline, targeting critical metals in Arizona, Nevada, Chile, and Peru. VerAI has announced its first exploration partnership in its portfolio in Northern Chile and has signed another agreement to develop an extensive portfolio in Peru. We have recently started developing a new portfolio in Ontario, Canada focusing on Cu, Au, Ni, and Co, and we are planning a new Li portfolio in North America. VerAI is in advanced discussions with several groups of Majors and Juniors that expressed interest in partnering with us on our portfolios in Arizona, Nevada and Chile. ■

Lithium exploration and development

Chile needs to establish a streamlined framework to advance projects in a booming market

Image courtesy of Albemarle

Half of the 10 juniors on the TSX Venture 50 list (a ranking of the top 50 performing TSXV-listed companies) for 2022 were lithium-focused, illustrating the wave that has been ridden by the sector during this dramatic run up.

However, although the share price performance of Chilean lithium explorers has been robust, cumbersome bureaucracy and uncertainty surrounding constitutional changes have limited growth. Moreover, outside of the two big producers active in the country, development has been slow.

In contrast, Chile's neighbor in the lithium triangle, Argentina, has been proactive in promoting the development of its lithium assets, particularly in the Salta province in the

northwest of the country. "The Argentinian environment for lithium mining development is more favorable and less regulated than in Chile due to the provinces controlling their resources and wanting to develop revenue streams for the benefit of their citizens," said Steve Cochrane, president and CEO of Lithium Chile (TSXV: LITH), the Canadian junior with a large portfolio of projects in Chile and Argentina.

In January 2022, Lithium Chile announced an initial resource of 1.4 million t of lithium carbonate equivalent from the initial pump test well on its Arizaro project in Salta, Argentina, which attracted a C\$34 million investment by Chengxin Lithium Group – the second largest lithium carbonate processor in China. Cochrane acknowledged the excitement in developing Arizaro, but also emphasized the company's continued commitment to the country it is named after: "Salta in Argentina is a fantastic jurisdiction, but prices are higher due to a shortage of rigs and skilled mining professionals, and from a value/investment standpoint Chile provides great opportunities that have not yet seen explosive demand."

Cochrane noted that the more radical proposals put forward by the Constitutional Committee, such as the nationalization of mining, were soundly defeated by vote on Saturday May 14th, 2022, and voiced his support of the government's intention to create a national lithium company with the goal of partnering up with private sector companies to jointly advance lithium projects. "This would be a far better, more transparent pathway to co-develop Chile's lithium assets rather than the current regulatory environment."

In March of 2022, Monumental Minerals Corp. (TSXV: MNRL) signed an option agreement with Lithium Chile to earn a 75% interest in its Laguna Blanca lithium brine/cesium sediment project, consisting of 23 exploration concessions totaling 5,200 ha. "Over the next three years (by March 2025), Monumental will spend C\$1.5 million on exploration, and make cash payments of C\$1.5 million. This deal makes Lithium Chile Monumental's largest shareholder, at 9.9%," detailed Jamil Sader, Monumental's CEO.

Sader mentioned that surface geochemical sampling and TEM geophysics were conducted by Lithium Chile over parts of the salar at Laguna Blanca, and these two datasets have identified highly prospective locations for drill testing of lithium brine and cesium in the sediment.

He added: "Drilling will commence at Laguna Blanca in Q3 of 2022."

Marcelo Awad, executive director of Wealth Minerals (TSXV: WML), the battery metals junior that holds the Atacama Salar and Ollague lithium assets in Chile, observed that President Boric and Mining Minister Hernando have both been clear with the message that Chile has to develop its lithium business. "We know that the window to develop lithium assets is now and perhaps for the next 10 to 15 years, because the substitutions are already at lab level. They are aware that in the future there may be products that replace a large part of lithium consumption," he reflected, suggesting that this has highlighted the importance of adding value to lithium production in Chile by developing downstream elements, most likely in the form of battery components rather than full-scale battery assembly.

Acknowledging the sharp run up in lithium prices from 2021 to 2022, Awad sees the longer-term price stabilizing at around US\$15,000 to US\$20,000 /t range. "This is comfortable for the likes of SQM and Albemarle that are mining the Atacama Salar, but will be a challenge for many hard rock or clay deposits elsewhere," he said, illustrating the inherent advantage that brine explorers in the lithium triangle hold over their hard rock counterparts in countries such as Australia. The challenge, however, is to create a framework that will support streamlined development.

One of Chile's most advanced lithium developers is Lithium Power International (ASX: LPI), which controls around 35% of the exploitable area at the Maricunga Salar, consisting of more than 2,500 hectares of mining concessions at its heart, including the company's flagship Maricunga asset. After completing its first exploration program at the Maricunga project in 2017, a DFS was released in early 2019, followed by an EIA and LPI's first lithium carbonate battery grade sample from its pilot evaporation ponds.

The company's initial objective was to produce 20,000 t/y of lithium carbonate for 20 years, using 100% of its mining concessions, with the original capex estimated at US\$600 million. In February 2020, LPI obtained the environmental approval from the Chilean authorities, and by March 2020 it had received bids for the EPC contract. However, the pandemic created uncertainties and delays, particularly on capex estimates. "The accuracy of capex estimates is critical to securing robust project finance with at least 50% leverage in our case," elaborated Cristobal García-Huidobro, LPI's CEO and managing director.

García-Huidobro explained that by the end of 2020, considering the impact that the pandemic had on development, LPI decided to move forward with a staged strategy by fast-tracking a first-stage development.

In 2021, LPI signed a MoU with Mitsui to become the off-taker in the future at prevailing lithium market prices, in addition to becoming one of the main equity partners in the Maricunga project. García-Huidobro commented: "This could represent one of the first equity investments of Mitsui in the lithium industry. Discussions have also included the Japanese Export Credit Agencies (ECAs), which could participate via a syndicated finance structure." ■



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The Laguna Blanca cesium sediment-lithium brine salar project located within the lithium triangle, Antofagasta Region, Chile.

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Can you provide a brief overview of Lithium Chile's portfolio of projects in Chile?

We currently have 11 projects in Chile, covering approximately 80,000 hectares. Our Laguna Blanca asset is JV'd with Monumental Minerals in Vancouver, who have the option to acquire 75% of the project.

We have a couple of major projects we are keeping to ourselves including Coipasa, the second largest salar in the world. Approximately 80% of Coipasa is on the Bolivian side and 20% on the Chilean side, and we control approximately 67% of the property on the Chilean side.

What progress has the company made with its Argentinian assets and what are your plans for 2022?

The Argentinian environment for lithium mining development is more favorable and less regulated than in Chile due to the provinces controlling their resources and wanting to develop revenue streams for the benefit of their citizens. The Salta province of north-west Argentina, where our Arizaro project is located, has been most proactive in promoting the development of their lithium assets.

We were introduced to the Galli family who have extensive experience in all aspects of lithium exploration and have a great asset in the heart of Salar de Arizaro, the fourth biggest salar in the world. We entered into a JV with SMG S.R.L. in April 2021, where we committed to a drilling campaign. Previously, an exploration well had been drilled which identified a lower aquifer showing a deposit with grades between 500 to 600 mg/l of lithium. We agreed on drilling a pump test well into that zone to evaluate the commerciality, and consequently drilled a 465 m production well and found a classic brine aquifer between approximately 320 - 452 m. Subsequent pump testing of that lower zone produced flow rates up to 50 liters/sec, some of the highest flow rates seen in Salta. Assay results from brines collected during that test showed lithium grades ranging from 250 mg/l to as high as 555 mg/l

In January 2022, we announced an initial 1.4 million t of lithium carbonate equivalent resource from our initial



Steve Cochrane

President & CEO
LITHIUM CHILE



The government has spoken about creating a national lithium company, with the goal of partnering up with private sector companies to jointly advance lithium projects in Chile.



pump test well on Arizaro. For the rest of 2022, we have a seven well program designed to drill four exploration holes and three production wells to expand the extent and the size of the resource.

Can you give details of the recent C\$34 million investment by Chengxin Lithium Group?

We are pleased to have Chengxin as a partner, who recently increased their stake in Lithium Chile from 5% to 19.86% via a private placement of 29,380,000 common shares of Lithium Chile at \$0.95 Cdn for gross proceeds of C\$27,911,000. The private placement, combined with Lithium Chile's current cash balance, gives the company working capital of C\$43 million with no debt.

As the second largest lithium carbonate processor in China, Chengxin not only brings financial clout to Lithium Chile but their production and processing expertise will prove invaluable in advancing our Argentinian play on Arizaro.

What are your thoughts on the current discourse in Chile surrounding lithium?

The global media has portrayed the new government and reforms as being negative for the mining industry, however, people on the ground in Chile

and the Ministry are keen on advancing the lithium industry. The government has spoken about creating a national lithium company, with the goal of partnering up with private sector companies to jointly advance lithium projects in Chile. This would be a far better, more transparent pathway to co-develop Chile's lithium assets rather than the current regulatory environment.

Salta in Argentina is a fantastic jurisdiction, but prices are higher due to a shortage of rigs and skilled mining professionals, and from a value/investment standpoint Chile provides great opportunities that have not yet seen explosive demand.

What do you think makes Lithium Chile an attractive proposition?

The optionality Lithium Chile has is second to none as not many juniors have the combination of capital, strategic backing, and multiple lithium projects in two of the top global jurisdictions. We now have an initial resource at Arizaro in Argentina with medium-term goals to advance this asset from 1.4 million tons to 6 million tons. Finally, we have a number of JV opportunities to advance some of our Chilean projects and two major projects in Chile we intend to advance ourselves. ■

Can you introduce Monumental Minerals Corp and describe the focus of the company?

Monumental Minerals Corp. is a mineral exploration company focused on the acquisition, exploration and development of mineral resource properties in the critical metals sector. The company is positioned to take advantage of the quickly changing and evolving transition from hydrocarbons to the electrification of our planet, especially in the automotive sector. The company has two high merit exploration projects: a heavy rare earth project in northeastern Mexico, and a lithium brine/cesium sediment project in Chile within the lithium triangle.

What is Monumental Minerals involvement at the Laguna Blanca project with Lithium Chile?

In March of 2022, Monumental signed an option agreement with Lithium Chile to earn a 75% interest in Laguna Blanca. The terms of the agreement are CAD\$200,000 cash and 3.4 million shares of Monumental. Over the next three years (by March 2025), Monumental will spend CAD\$1.5 million on exploration, and make cash payments of CAD 1.5 million. This deal makes Lithium Chile Monumental's largest shareholder at 9.9%.

We see Lithium Chile as a valued joint venture partner. They have a track record of discovering and developing quality projects in Chile and Argentina and have tremendous experience in the region, something we hope to capitalize on.

The Laguna Blanca project itself is located within the prolific lithium triangle, a zone within the central Andes high desert that includes Chile, Argentina and Bolivia. The project consists of 23 exploration concessions totaling 5,200 hectares.

Can you tell us about the Jemi rare earth element (REE) project, and the potential you see for it to contain heavy rare earth elements (HREE)?

Jemi sits within the North American Alkaline Igneous Belt, an under explored north-south trend over 3,000 km long of alkaline igneous rocks and carbonates that are host to numerous REE, gold and other critical element depos-



Jamil Sader

CEO
MONUMENTAL MINERALS CORP.



Monumental Minerals has two projects that contain critical metals necessary for the global energy transformation.



its. The Jemi project hosts numerous REE occurrences containing economic concentrations of the high value magnetic REEs including the HREEs dysprosium (Dy) and terbium (Tb), and the light rare earth elements (LREE) neodymium (Nd), praseodymium (Pr). These REEs represent 94% of the REE market by value and are used almost exclusively for the manufacture of high performance magnets that are used in EVs, wind turbines, and other electric motors. The project also contains associated tantalum (Ta), niobium (Nb), and zirconium (Zr).

The project is situated within the state of Coahuila, and is about 40 km south of the Texas border. The proximity to Texas is important, as it is a fast-growing North American hub for the downstream REE industry (refinement and manufacturing).

Where is Monumental Minerals focusing its exploration efforts in 2022?

Monumental will be focusing our exploration efforts at both Jemi and Laguna Blanca in 2022. At Jemi, we plan to first carry out a field program consisting of mapping, ground geophysics, and geochemistry. The results of this program will give us the confidence we need to ensure that our 2022 drill targets are positioned to have the highest probability at intersecting high grade REE

mineralization. The drill program for Jemi in 2022 is estimated at 2,500 m, or about 8 holes at 300 m each.

At Laguna Blanca surface geochemical sampling and TEM geophysics was conducted by Lithium Chile over parts of the salar. These two datasets have identified highly prospective locations for drill testing of lithium brine and cesium in the sediment. Further exploration and sampling of both sediments and brine groundwater is planned for 2022.

How would you evaluate Chile and Mexico as mining jurisdictions?

Chile has been a stable mining jurisdiction for several decades and that is not likely to change. There has been much talk recently about articles within the new constitution that would drastically change mining laws. However, the more extreme proposals, including the nationalization of mines in Chile, did not pass by a large margin.

Mexico always ranks well on the Fraser Institute global survey of mining jurisdictions. While some regions in the Mexico can be more dangerous due to criminal activity and drug cartels, the state of Coahuila is significantly safer. In addition, the state has a very resource-based economy that consists of iron ore, coal, base and precious metals, fluorite, and ranching. ■



“There is no development or consolidation of any company if innovation is not on the table. That also goes hand in hand with sustainability; innovation is necessary for desalination plants, but also when planning social projects to integrate communities and ensure environmental stewardship.”

- Sandro Tavonatti,
CEO,
Sigdo Koppers Ingeniería y Construcción (SKIC)

ENGINEERING, CONSTRUCTION & CONSULTANTS

Image courtesy of BHP

Engineering & Consultancies

From conception to closure: Solutions for the full mining lifecycle

Chile's evolving regulatory framework and increasingly stringent environmental regulations mean that the engineering firms and consultancies active in the mining space have their hands full. The question of whether new legislation will stunt project development remains to be seen, but with no radical overhaul expected, the outlook in this segment of the industry looks robust for the years ahead.

One of the themes that have been gaining traction in recent years is mine

closure; a perpetual challenge for mining companies for centuries, but one that is subject to ever-more scrutiny. Although the issue of mine closure is not new, the industry has traditionally struggled with it due to changing legislative scenarios, commercial pressures, ESG-related challenges and poorly planned costs.

"Regulations require you have a closure plan before you even move the first stone," observed Esteban Hormazábal, managing director of SRK

Consulting Chile, who referenced international standards from ICMM, APEC, ECLAC and the World Bank as guidelines for good practice. "Mine closure is a matter that must be approached from a multidisciplinary and integrated perspective; from the design, construction and operation of a mining project to its implementation," he said, explaining that integrated engineering is required because both physical and chemical stability must be reviewed, including concepts of geotechnics, hydrogeology and geochemistry.

"Regulation must be done during prefeasibility studies. From there you should already have at least a draft of a closure plan," added Hormazábal, citing SRK's work at Gold Fields' Salares Norte project in Chile as an example of the company's work in this field from the prefeasibility stage to the detailed engineering.

In 2020, Turner & Townsend collaborated on the 'Planning for successful rehabilitation' report, underscoring the case for early planning for closures and financing such closures. "It also highlighted some of the challenges in closure and confirmed the need to find alternative options for a rehabilitated mine," revealed Mark Wainwright, Turner & Townsend's managing director – mining, giving the examples of site greening, renewable power sources and job creation schemes related to eco-tourism as options.

"We think the study helped deepen industry awareness of the environmental impact and socio-economic benefits of sound mine closures. With the growing calls for a decarbonized mining industry, this is one of the levers that can be used to enhance the reputation of

the sector," reflected Wainwright, adding that the necessity to rehabilitate properly is not only a statutory duty but impacts on the future of the business – 'the social license to operate' – as a part of corporate ESG responsibilities which shareholders are watching carefully.

One of the trends in mining engineering in recent years has been the preference of clients to work with fewer contractors, as the industry leans towards a model whereby one company, such as an EPCM, manages various responsibilities.

Global mining engineering firm Ausenco has worked on many of the emblematic development projects in Chile in recent years, including BHP's Spence Growth Option (SGO), Teck's QB2 and Antofagasta's INCO project. Claudio Lesch, Ausenco's president for South America, highlighted the lumpsum, turnkey EPC contract that Ausenco was awarded for the Mantoverde project as a particular example of the type of contract model companies are now seeking. "This project is not just a milestone for us, but also for the industry, as it is a different type of contract modality in Chile," he commented, adding that approximately 90% of the engineering is completed (as of May 2022), all the equipment and construction contracts have been secured, and construction is progressing.

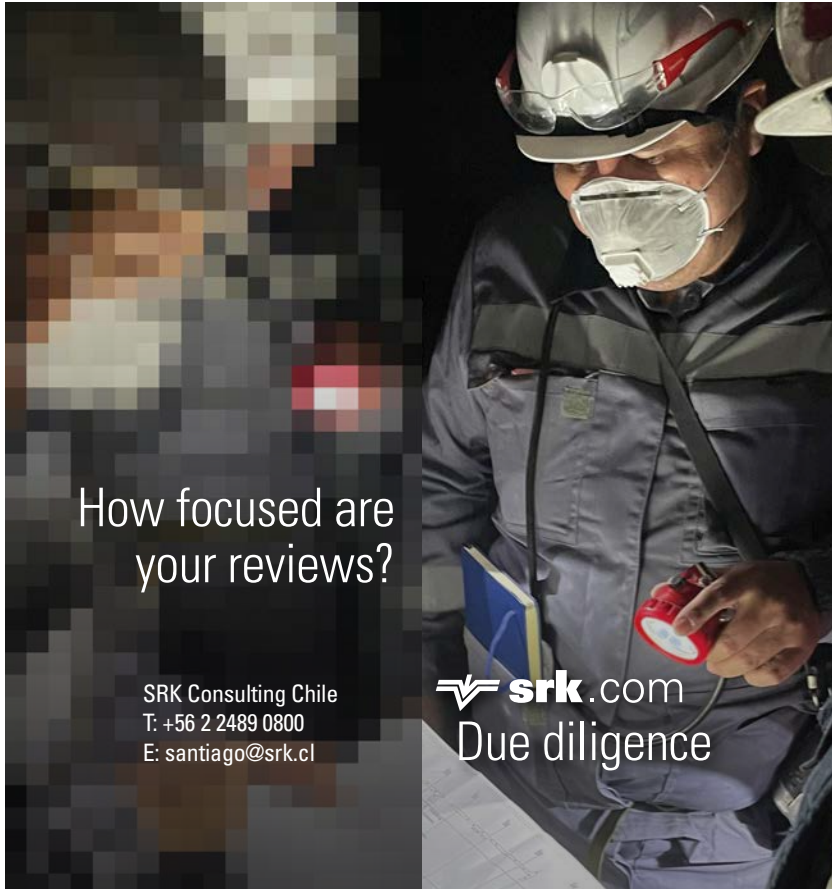
Iván Rayo, general manager of Chilean engineering firm JRI, also spoke of the benefits of being involved in mining

projects throughout their lifecycle, and on that note, was pleased to report that in 2021, unlike the previous year, there was more value engineering work in Chile such as conceptual studies, optimization projects and concentrate process debottlenecks. "A large part of these value engineering projects are transformed into long-term investment projects," explained Rayo, suggesting that better metals prices are stimulating this demand.

JRI celebrates its 40th anniversary in 2022, and has been involved in one of the most emblematic long-term projects in Chilean mining – Codelco's Rajo Inca development, which will extend mine life at the State-run company's Salvador division until 2065. JRI has developed all of the engineering studies for the Rajo Inca project since 2016, starting with the value engineering and conceptual studies with an integrated scope (mine, plants, tailing dumps and infrastructure), then the feasibility study, and currently the detailed engineering. "We support the contracts of the operational teams and, as the only engineering company that has interacted with Codelco in this project, our participation is fundamental," stated Rayo, noting that JRI has developed the project with modern work methodologies such as Lean Full Design, BIM 4D and Advance Work Package (AWP).

Another Chilean engineering firm to celebrate a landmark anniversary is Metaproject, which turns 30 in 2022, and also works with Codelco – taking charge of the tender and asset contract management of all the company's divisions. Dominique Viera, Metaproject's vice president of operations, discussed some of the common mistakes made during the lifecycle of a project from an engineering standpoint: "Nowadays projects get delayed because there is a siloed chain from the engineering conception to the different stages throughout a project," she said, explaining that there can be discrepancies because these stages are often tendered between more than one engineering company, and an excessive part of the budget is given to the construction companies in very early stages, resulting in the following tenders being given to the cheapest bidder. "However, if you buy cheap, you often end up paying twice. In the end, the client has to do contractual modifications resulting in a more expensive and longer project."

Viera went on to elaborate on the main benefit of the multidisciplinary engineering approach that Metaproject adopts: "A holistic view and clear project management comes from being involved in the design stages with the client, where both parties have a vested interest because they will be involved throughout the life of the project." ■



How focused are your reviews?

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T: +56 2 2489 0800
E: santiago@srk.cl

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Water and the Environment

A 12-year drought in Chile has highlighted water scarcity as a major issue



Image courtesy of Antofagasta plc

Undoubtedly one of the focus areas for all businesses in Chile is water supply, as the country has experienced a 12-year drought. At Exponor 2019 in Antofagasta, protestors stormed the conference with a sign stating 'We will not be a sacrificial zone', in reference to the water consumed by mining producers in the region. This was before the riots in October 2019, before the vote for the new constitution, and before Chile elected a president with an environmental mandate.

An illustration of the water intensity of certain mining processes can be seen in the extraction of lithium from brines, which can consume nearly 2 million liters of water to produce one ton of lithium. For an average family, it would take 36 years to consume 2 million liters of water. Although the numbers are striking, Rohitesh Dhawan, president and CEO of the International Council on Mining and Metals (ICMM), pointed out that when you examine the amount of water the mining industry consumes relative to other sectors, it is actually

still very small. "In Chile, agriculture and livestock consumes 73% of water, drinking water is approximately 11%, industry is 6%, electricity is 4.5%, and mining consumes only 4%. Then if you look at where this 4% comes from: approximately 1/4 comes from surface water, another 1/4 comes from the sea, and 43% comes from underground sources," detailed Dhawan, noting that amongst the large players in Chile which are ICMM members, approximately 3/4 of the water used is typically recycled.

Central Chile has experienced a drought for the last 12 years, prompting Antofagasta Minerals (AMSA) to build a seawater desalination plant for its Los Pelambres mine in the Choapa Valley, via its INCO project, the first stage of which is due to start operation in the second half of 2022 with an output of 400 liters per second. "Our target is for raw or desalinated seawater and re-used or recycled water to supply 90% of the operational water use at all our mining operations by 2025," revealed Iván Arriagada, CEO, Antofagasta plc.

Desalination plants mean more capex for mining companies, and water scarcity also significantly drives up costs. In 2021, AMSA's net cash cost to produce a tonne of copper was US\$1.20/lb, and Arriagada acknowledged that the 2022 guidance of US\$1.55/lb net cash cost was partly due to the expected impact of drought this year at Los Pelambres, in addition to declining grades at Centinela Concentrates.

Cochilco estimates that mining's use of seawater — either used directly or desalinated — will increase by 167% by 2032, while freshwater use will decline 45%, meaning that 68% of water used by the industry will come from the ocean. The breadth of companies featured in this article also illustrates how water encompasses all aspects of the mining business, from engineering and consultancies to construction and technology providers. A multi-stakeholder approach is necessary to confront the issue of water scarcity, which represents opportunities.

"I believe that from now onwards, no mining project will be approved with fresh water, and everything will need to be done with salt water," stated Martín Valdes, partner and head of Fund VII at Resource Capital Funds (RCF).

This sentiment was echoed by Dave Lawson, president – mining and metals at Wood, who commented that all new mines in Chile are going to use sea water of some description, "whether it is desalinated water used as potable water or non-desalinated water used in processes."

Lawson went on to discuss some of the cost analysis considerations related to using sea water, such as the construction materials having to be dif-

ferent due to salt water being highly corrosive and the need to replace materials on a more frequent basis.

At the moment, desalination projects are the realm of the major miners who can afford the substantial long-term investment necessary. However, a future where public/private joint ventures can guarantee water supply for a wider base would make using desalinated water viable for more stakeholders. Lawson elaborated: "If you can build a desalination plant that serves multiple consumers from various industries, costs can be shared, making more sense from an economy of scale standpoint. If the government can invest in desalination plants and use some of that water to supply cities and towns, it can offset some of the costs for smaller players in various industries."

Tomás Fischer Ballerini, general manager of Edyce, spoke of how the Edyce-Arrigoni engineering team worked in close collaboration with Antofagasta's engineering team to look for efficiencies regarding the steel structures of the INCO project. "It is not the first desalination project in Chile, but it is by far the biggest," said Ballerini, noting that Chile needs more projects like this if the country wants to continue attracting mining investment.

ANDRITZ has been involved in desalination plants for mining projects by digitalization their engineering, according to Andrés Rojas, ANDRITZ' automation director – Latin America, mentioning work the company has done in this area for BHP, Teck at QB2, and with AMSA at INCO. "Once in operation our technology makes the use of energy and water consumption more efficient, optimizing its transportation and energy costs through the incorporation of digital sensors," said Rojas, commenting that there are many pumps pushing water that can be made more efficient with this technology and that ANDRITZ also improves water use through its solid-liquid separation equipment, both in concentrators and tailings management, to recycle the water used in these treatments.

Luis Soruco, general manager of Arcadis Chile, discussed the water-related engineering and consulting solutions his company offers, expanding on the issue beyond desalination plants

and into the handling of water inside current operations. He commented: "Included in this is the consumption or evaporation of water in tailing dams, which is a challenge because it loses more water than any other part of the operation, therefore concentration in the tailings dam is one of the focuses for hydric efficiency in our technical analysis. Our goal is to minimize hydric use and stress through new technology and solutions."

John Crane has been providing products for the mechanical sealing of rotating equipment for decades, but in the last three years, the company has developed more specific products that aim to conserve or reduce water usage. Carlos Ramírez, John Crane's general manager for Chile and Peru, explained that usually a seal must have water that lubricates it to prevent wear, but today, with the implementation of diamond seal face technology, equipment can withstand extreme temperatures without the need for lubrication. "In mining, due to the complexity and harsh environments that

rotating equipment are used in, generally we see very short life cycles," said Ramírez, commenting that John Crane works with pump manufacturers such as Weir Minerals, Metso and FLSmidth to increase the uptime of their equipment through new technology, including mechanical seals, which can last up to 18 months and do not use water.

Companies that have traditionally worked outside the sector are also bringing their technologies to the mining market, such as Carpi Tech, which specializes in the waterproofing of hydraulic structures using synthetic geomembranes and geo-compounds. Pascual Perazzo, Carpi Tech's business development manager for Latam, recalled how the company entered the mining market eight years ago working at a mine in Iran after a recommendation by tailings specialists ATC Williams: "There we made our first tailings dam with the CARPI waterproof membrane. Consequently, we have made several hydraulic structures for mining to supply water to operations." ■



We will digitalize the engineering of the INCO desalination plant and we have been training the operators. We created a simulator in which Antofagasta's operators can increase their dexterity and skills to be ready from day one once the operations commence.



**– Andrés Rojas,
Automation Director – Latin America,
ANDRITZ**



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Can you tell us about Wood's work at some of the emblematic Chilean mining projects in the last year?

Our role as the integration contractor for BHP's new copper concentrator at the Spence mine is a great example. We still have a small team on site, but we've effectively completed the integration. We are also just finishing a lithium project for a client in the north of Chile which has been extremely successful.

We are currently involved in a number of projects, the biggest of which are Codelco's Chuquicamata project, where we are doing the detailed design for underground mining and early works for Antofagasta Minerals' Minera Centinela project. We are also involved in a significant amount of proposal study work and have long-term engineering contracts with mining companies in Chile.

What are some of the considerations for mining companies looking to source water for operations?

From a broad water perspective, looking at new mines in Chile, I would expect that all are going to use seawater of some description – whether it is desalinated water used as potable water or non-desalinated water used in processes. If you want to use seawater, the materials for construction have to be different because salt water is highly corrosive. The cost analysis also needs to be considered as desalination plants can become incredibly expensive, as well as the need to replace materials on a more frequent basis than what you would do otherwise. We have to reduce water consumption and find ways to use every liter of water multiple times, and Wood can contribute engineering solutions for both water management and recycling. A mixture of private and public money is required to make using desalinated water worthwhile and viable for more stakeholders.

Can you elaborate on what Wood's 'Mine 2050' concept aims to achieve?

The energy transition starts and ends with mining. There is a huge mismatch between the world's climate ambitions and the availability of critical future-facing metals needed to resource the



Dave Lawson

President – Mining & Metals,
WOOD



Projects are going to get bigger and more expensive due to the amount of rock we have to mine and move around to produce the copper needed to meet the demand, especially as ore grades are declining.



energy transition. If you look at the demand of copper alone, in order to achieve the net-zero 2050 targets, analysts suggest it will take around 19 million tons of additional copper. The largest copper mine in the world is Escondida, and that figure equates to a new Escondida that must be discovered and entered production every year for the next 20 years to meet the projected increase in demand, bearing in mind it currently takes 12 to 15 years to move a mine into production. Progress has to be achieved faster, better and safer, and Wood is supremely focused on the solutions we can provide to address the urgency and achieve those net zero target and support our clients as they look to reach their sustainability goals. This includes working on digital technologies related to the energy transition, such as carbon capture, and developing integrated energy solutions through the deployment of our renewables arm.

What type of renewable energy projects do you expect to play a role in the development of mining?

I believe that all renewable sources of energy such as wind, solar, green and blue hydrogen will play a role. For example, Wood is doing work for a client in Chile to supply hydrogen for all their

trucks. We have a division that specializes in hydrogen development. We also have the ability to deliver renewable solutions to reduce the carbon intensity of mining operations.

Which areas of Chile's mining business do you see as having the strongest potential for growth for Wood?

Projects are going to get bigger and more expensive due to the amount of rock we have to mine and move around to produce the copper needed to meet the demand, especially as ore grades are declining. As a global company we can harness a broad range of expertise along with a diverse range of cross-sector solutions to ensure our clients' operations are future-ready, efficient and sustainable. Finally, we have a strong digital technology division, which I believe will see significant growth in the coming years as mines become green and integrate value added technologies into their operations. Digital twins are in particularly high demand. In summary, as the world's needs and our clients' needs continue to evolve so will our solutions. Our track record of managing mega projects along with our know-how in digitalization and automation will see Wood's presence in Chile continue to grow. ■

How was 2021 for JRI, and which of the company's services were in most demand?

2021 was a very good year for JRI, as we managed to fulfil our business goals despite the challenges facing the industry both globally and locally. One of our main achievements was advancing the engineering of Codelco's Rajo Inca project.

Another important element was that in 2021, unlike the previous year, there were more value engineering projects such as conceptual studies, optimization project and concentrate process debottlenecked. A large part of these value engineering projects are transformed into long-term investment projects.

The Rajo Inca development is going to extend mine life at Codelco's Salvador division until 2065. Can you tell us more about JRI's involvement with this project?

JRI has developed all of the engineering studies for the Rajo Inca project from 2016. We started with the value engineering and conceptual studies with an integrate scope (mine, plants, tailing dumps and infrastructure), then the feasibility study, and right now we are finishing the detailed engineering. We support the contracts of the operational teams and, as the only engineering company that has interacted with Codelco in this project, our participation is fundamental. JRI has developed the project with modern work methodologies such as Lean Full Design. BIM 4D and Advance Work Package (AWP)

JRI designs treatment plants, designs pipeline systems for water and mineral transportation, and designs tailings dams. Can you explain how these services help the sustainability of a mining operation?

JRI's business is distributed into four business units: plants, pipelines, dams and underground mining. In each of them, we address not only the design but also the sustainability component. We have a sustainability team at JRI that analyses the environmental and community aspects, permitting, and social license to operate. Within JRI's sustainability team there are specialists for each of the business areas. For instance, sustainability problems in tailing



Iván Rayo

General Manager
JRI



In order for projects to be approved, they have to meet many requirements, including engineering, and we provide this service so that mining companies can manage their core business.



dams are not the same as in an underground mine. In order for projects to be approved, they have to meet many requirements, including engineering, and we provide this service so that mining companies can manage their core business.

What would you say are the main differences between operating in Chile and Peru?

In Peru there is no large state mining corporation. Codelco is socially obliged to invest to maintain the copper production level, and accounts for over US\$68 billion accumulated in Chile's mining investment pipeline, more than 5% of all investment made on the country. A private company does not necessarily have to do it, if business is not good enough, or metal prices are low, or there is country risk. Peru depends more on the international market and private companies, and from our standpoint it can mean that engineering demands can be intermittent.

From a technical development point of view the two countries are very similar, with allows for synergies to engineering companies that work in both jurisdictions.

To what extent do you think political changes in Chile could impact the country's mining sector?

Royalty and regulatory decisions such as those being discussed today in Chile directly affect mining, and they impact the interest of international investors. For those of us operating in Chile the concern is high, as there is uncertainty. I have seen a certain animosity towards mining from some Chilean collectives that are anti-mining based on weak levels of information. They rather perceive dogmas than reality. As an industry, it is important for us to take action so as to show what is really being done, and demonstrate to Chilean society that mining is socially responsible and necessary for the country to prosper.

What would you like to achieve with JRI in Chile in 2023?

For 2023, we have a strategic plan that we updated last year related to diversifying as an engineering company. This includes looking at industries such as energy, and implementing more digital systems engineering, which is a path we started a long time ago but one which is gaining relevance. We also want to resume work outside of Chile.

JRI celebrates its 40th anniversary in 2022. Through 40 years of project development we have worked hard to advance the development of Chilean mining, and for any mining client, JRI is going to be able to bring a lot of real experience. ■



Claudio Lesch

President – South America
AUSENCO

What have been the main milestones achieved by Ausenco in Chile in the last few years?

The past two years have been great for Ausenco in Chile. We have consolidated our growth and are today one of the leading firms in Chile. Currently we have approximately 800 people in our Santiago office.

An important milestone was to be awarded the lumpsum, turnkey EPC contract for the Mantoverde project. We have completed approximately 90% of the engineering, have all the equipment and construction contracts secured, and are progressing with the construction. This project is not just a milestone for us, but also for the industry, as it is a different type of contract modality in Chile.

Another milestone has been working on BHP's Spence Growth Option (SGO) project where we completed commissioning in 2021. We are currently conducting studies for the upgrade of the existing concentrator at Spence. We are also working with Teck to support the commissioning of QB2 and recently secured a contract with Antofagasta Miner-

als for the commissioning of INCO. We are currently in the process of ramping up the project. Other standout projects include a feasibility study for the expansion of Sierra Gorda and various master service agreements with Anglo American, Codelco, and others. In addition to our work with large mining companies, we are involved in many studies with juniors.

What is Ausenco's approach to further consolidate itself as the partner of choice in the coming years?

Ausenco believes in creating lasting partnerships with our clients. We strive to create value at every project stage – from early identification through feasibility and delivery studies, conceptual design, all the way to execution, commissioning and operation. We have a long history in the mining industry, and we understand clients' needs.

We have helped many smaller mining companies raise money, and worked with majors to develop large projects, so Ausenco covers the full spectrum. We pride ourselves in offering cost-efficient designs and ensuring excellent project execution. ■

Can you provide examples of some of the scoping and engineering studies SRK has been involved in?

Our global experience gives expert, integrated solutions on every phase of a mining project. We have been involved from the scoping studies and conceptual engineering stages, to detailed engineering for world-class underground (UG) projects and operations globally. Some of the most emblematic projects are Anglo's Los Bronces project in Chile, Finsch (South Africa), Resolution & Bigham Canyon UG (USA), Alpala (Ecuador) and Oyu Tolgoi (Mongolia).

At Los Bronces we have been working for over 12 years, from the construction of the exploration tunnel with TBM, to generating the basic engineering and the basis for the tender and construction, and during the development of the underground project, from profile engineering down to the pre-feasibility stages.

What are your views on the issue of water scarcity in Chile and how it pertains to mining?

Faced with a snowballing scenario of water scarcity, the supply of drinking water will be prioritized, protecting continental waters from other uses. This will lead mining projects to search for new sources of water. The use of seawater by large-scale mining is increasingly frequent and could soon become an eventual requirement. While seawater and desalination plants may be a viable option for large mining companies, due to the associated capital costs, this would not be an option for small and medium-sized mining companies. Water supply options for these may arise through government programs, synergies between companies or other options, quite possibly generating new business opportunities. Innovation and development will be fundamental in the future for optimizing water use in mining.

Can you elaborate on the main factors mining companies must consider regarding mine closure?

Mine closure is a matter that must be approached from a multidisciplinary and integrated perspective, from the design, construction, operation of a mining project to its implementation. This vision has been validated and adopted by the industry, and to date there



Esteban Hormazábal

Managing Director – Chile
SRK CONSULTING



Mine closure requires integrated engineering, because both physical and chemical stability must be reviewed.



Can you introduce Metaproject and describe its activities in the mining sector?

Metaproject has provided services for the mining, infrastructure and petrochemical industries for the last 30 years. We began developing multidisciplinary engineering in all phases, mainly in mining environments, but nowadays we are a lot more diversified. We have a services division, a division for project management that entails technical inspection and geo-measuring, and now a division to support contract and supply areas. We are in charge of the tender and management of assets contracts of all the divisions of Codelco, and we also work with Anglo American and ENAP. From the sketch of an idea to construction, our engineering and project management follows all steps of an operation, in addition to offering back-office and front-office administrative support.

How can investment in multidisciplinary engineering help maximize operational productivity?

Nowadays projects get delayed because there is a siloed chain from the engineering conception to the different stages throughout a project. The main benefit of

a multidisciplinary engineering approach from one company is that a holistic view and clear project management comes from being involved in the design stages with the client, where both parties have a vested interest because they will be involved throughout the life of the project.

What would you say are the main barriers for the adoption of innovation at mining operations?

People, without question. Change has to come from the top and you need the buy-in of the operators for technology to be successfully implemented. The pandemic has helped, but changing the mindset of a traditional industry still takes time.

Metaprojects celebrates its 30th anniversary in 2022. Why the company has achieved longevity in Chile's mining sector?

Metaproject has been living and implementing technological changes for 30 years and we have evolved because of our versatility. We can help clients adhere to budgets by redistributing resources or utilizing our experience to suggest different solutions. ■

are different internationally recognized standards and guides as well as good practices in mine closure, such as those published by ICMM, APEC, ECLAC, the World Bank, among others. SRK Consulting has a multidisciplinary team in the mine closure field. The planning of closure programs involves the implementation of scheduled, anticipated, and progressive closure activities for the optimal use of the company's resources and the possibility of facing in a timely manner the technical, environmental and regulatory challenges.

Mine closure requires integrated engineering, because both physical and chemical stability must be reviewed. It means that concepts of geotechnics, hydrogeology, geochemistry, and mine planning are necessary to determine and assess the closure measures. Regulations must be put in place during the pre-feasibility studies; from there you should already have at least a draft of a closure plan. We worked on the Gold Field's Salares Norte project from the pre-feasibility to the detailed engineering stages, including the mine closure plan. Regulations requires you to have a closure plan prior to even moving the first stone.

To what extent do you think the environmental focus of the new government in Chile could impact demand for the services that SRK offers?

For investment projects, if requirements were to be increased, we could possibly see the following impact our business: Requirements for larger and more robust technical studies to assess impacts and risks, and to define mitigation or compensation measures; specialized technical studies with an emphasis on innovation and new technologies applied in other parts of the world. More data, new methodologies and new technologies are already becoming part of the analysis required to obtain environmental permits globally, and it is a trend we expect to continue.

What are the main themes you see impacting the Chilean mining industry in the years to come?

One of SRK's focuses for the years ahead is to help mining companies integrate new big data technologies with new software, to have an integrated product to generate a geoscientific model. The mining industry currently uses drones to help map, for geotechnical and structural characterization, safety and mine planning purposes, radar equipment to monitor slopes behavior; all of which provide information, but often in diverse departments rather than on an integrated platform. We want to help them consolidate all that information on one platform, with the software that already exists. ■



Dominique Viera

Vice President of Operations
METAPROJECT



Construction & Contractors

Innovation is necessary to improve productivity amid workforce shortages

Image courtesy of Echeverría Izquierdo

A January 2022 report from SENCE Labor Observatory's Employment Exchange Analysis System (SABE) showed that as of November 2021, job vacancies in Chile had risen 39% in the 12 months previous, with total job applications decreasing by 31% in the same period. This mirrors a global trend in the mining sector, which has struggled to attract the next generation of talent.

"One of the biggest challenges has been overcoming the lack of qualified workforce, which is still an issue today (May 2022)," reflected Sandro Tavonatti, CEO of Sigdo Koppers Ingeniería y Construcción (SKIC), the Chilean construction and EPC firm that employs over 14,000 people. In addition to working on the standout open-pit mining developments

in Chile including QB2 and Salares Norte, Tavonatti highlighted the challenges of working in underground mines such as Codelco's Andina and Chuquicamata operations, particularly in an era of social distancing in a finite space. "It means you have to think outside the box, developing projects with less people and more technology," he commented.

On that note, SKIC has been working on the development of robotics and AI with the support of companies such as Godelius, which is part of the Sigdo Koppers group, with the aim of expediting diagnostics and analysis and reducing the exposure of people to risks. Tavonatti gave the example of the alliance made with Boston Dynamics to incorporate their Spot dog robots at SKIC's operations.

Mario Theurl, managing director of Züblin Strabag Chile, the multinational construction company, also spoke of the challenges of working underground, including the risk of rocks bursting. He explained how the company is dealing with seismic conditions at El Teniente: "We have engaged in a tele-commanded machinery program in El Teniente – a mine which is particularly seismic – so we can operate machinery from outside of the tunnel, keeping our personnel safe."

When asked about the impact of digitalization on the underground mining industry, Theurl observed that the sheer amount of products on the market presents a challenge.



Safety is fundamental for any operation. The key, we have learned, is planning. We have to understand that our activity requires a total synergy, and our operators understand that they are dedicated to professional labor."

**- Felipe Fossatti,
Commercial Manager,
Multiservice Grúas**



"Technologies are moving sometimes too fast for people to properly digitize their operations. Without being able to effectively adopt and learn, we could be prone to errors that may cost money and result in delays," he noted, emphasizing the importance of focusing on adopting the right developments for each operation. He summarized: "No project should add digital tools just because they are digital – technology must fit the organization and our clients' priorities with the aim to advance our industry."

Darrell White, executive general manager – Americas for Thies, pointed out that statistically, operations with the safest workplaces are the most productive, and technology plays an important role in improving both of these factors. He mentioned that autonomy is assisting safety, giving the example of the autonomous and semi-autonomous dozer and drill fleets that Thies operates in Australia, and revealing that the company will deploy its first autonomous truck fleet in Chile later this year. He added: "We are seeking out the right opportunities with the right clients in Chile to deploy similar technologies here, which will help reduce the number of people on site, particularly in high altitude areas."

While acknowledging the importance of technological advancements, White stressed the continued relevance of the human element, something that should not be forgotten in the digital era: "Technology supports the decision-making process of workers, and at the end of the day, it's still people who operate equipment and make decisions on site. Our approach is to combine technology with training to aid transformation in mining, which is increasingly important as we see ore grades decline."

Safety in mining construction

The construction industry has had to withstand multiple challenges in the last two years. In 2020 and 2021, Covid-related work-from-home measures meant many projects had to scale down, and when they restarted, severe supply chain delays and rising logistics costs meant that profit margins and completion dates were compromised.

Despite dealing with such complexities, Darío Barros Izquierdo, general manager of Echeverría Izquierdo Montajes Industriales, mentioned that the company never stopped operating in 2021 with a crew of up to 9,000 workers. He cited the company's work on the primary crusher, two overland conveyors, a stockpile, the reclaim tunnels and a lime plant at Teck's QB2 project as a particular success, suggesting Echeverría Izquierdo's years of experience at Collahuasi's operations meant workers had previous experience in challenging climates.

For the past six years, Echeverría Izquierdo has been recognized by the Chilean Chamber of Construction for workplace health and safety standards, and Barros spoke of the factors which contributed to this recognition: "We outsource very limited activities, and we work with our own cranes and major lifting equipment. We therefore know their story and maintenance as well as the operator and rigger. We have a centralized Rigging department that has an exhaustive review process to ensure the safe performance of hoisting and rigging activities."

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The STRABAG group is one of the world's leading companies in construction and technology, overseeing 12,000 projects a year with a workforce of 75,000 employees worldwide. It operates under two brand names in South America: ZÜBLIN, a household name in mining and STRABAG, specialized in tunnelling and infrastructure.

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Image courtesy of Sigdo Koppers

Another company to have worked at QB2 is ULMA Construction, specialists in concrete formwork and scaffolding solutions. Antonio Carlos Machado, ULMA's commercial director in Chile, highlighted the importance of product diversity: "For many mining operations a single type of product, technologically speaking, would not be able to address the entirety of a project. The combination

of the different systems ULMA makes the entire construction process more productive and safer. The safety aspect is the most important point to highlight, as it is fundamental for mining."

Machado added that ULMA's multidirectional scaffolding system, MK, contains a variety of metal profiles that form a kind of large-scale Meccano, well-suited to large-scale mining projects

with large load capacities where the project engineering needs a system with resistance characteristics superior to what is traditionally offered.

MJ Gerüst, the multinational German scaffolding manufacturer, also offers multidirectional solutions. Christian Abt, MJ Gerüst's area sales manager for the Americas, gave an example of how such products are applied to mining settings: "Acid, water and petroleum ponds which mining companies use for storage could be easily solved by our frame and multidirectional solution, which is the Uni-Connect and Combi system, fulfilling the highest safety requirements. Ball Mills, crushers, truck shops and conveyor maintenance are suited to our MJ Combi and MJ Optima solutions."

Abt went on to say that if the industry is truly seeking to innovate, reduce cost and human exposure, then MJ Gerüst's Optima system, a hybrid solution that is lighter and can be erected faster, is the type of technology that will significantly improve mining operations.

Felipe Fossatti, commercial manager of Multiservice Grúas, the Chilean company known for its self-propelled jib cranes, spoke of the importance of planning when it comes to safety, and he also highlighted the human aspect: "It is not enough to have a new crane or the latest technology, but the operator needs to have the proper training (...). We have to understand that our activity requires a total synergy, and our operators understand that they are dedicated to professional labor." ■



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How has SKIC evolved in recent years to expand the scope of its business?

SKIC started evolving four years ago, from a company of industrial assembly and construction into an EPC company. This coincided with how, today, our main clients prefer to focus on their core business and they leave the day-to-day engineering, procurement and construction to the contractors. An area we have been developing, for example, is maritime ports; we are now very proud to have important offshore projects with Collahuasi and Teck.

What have been some of the technical challenges working on large-scale projects such as QB2?

One of the biggest challenges has been overcoming the lack of qualified workforce, which is still an issue, especially considering the altitude of projects such as Teck's QB2 and Gold Fields' Salares Norte. Underground mines like Andina and Chuquicamata for Codelco also pose challenges. For instance, besides the logistics and health support for all workers (we employ over 14,000 people), innovation is necessary because there are limitations in terms of capacity and social distancing at projects. It means you have to think outside the box, developing projects with less people and more technology.

Could you give example of new technologies that are improving productivity and safety at mine sites?

We have been working on the development of robotics and AI with the support of other companies such as Godelius, which is part of the Sigdo Koppers group, with the aim of expediting diagnostics and analysis and reducing the exposure of people to risks. In terms of our innovation projects, we made an alliance with Boston Dynamics and we have incorporated their Spot dog robots in our operations. Introducing new technology is not only an incentive for new generations, but also good for clients because it forces all parties to work hand in hand to make processes more productive.

Can you elaborate on SKIC's collaborative approach with engineering and service companies?

Our decision to evolve into an EPC



Sandro Tavonatti

CEO
SIGDO KOPPERS INGENIERÍA Y CONSTRUCCIÓN (SKIC)



There is no development or consolidation of any company if innovation is not on the table. That also goes hand in hand with sustainability.



company immediately forced us to create alliances. Our focus is not to develop and set up a big tech company, but form strategic partnerships for the future. We work with Fluor Canada, Worley Parsons, Bechtel, and a number of smaller specialist companies, from the proposal study stage. Beyond the technical issues, the first thing we evaluate is that we share the same values and can merge culturally. That is very relevant. We have been doing it for several years and it is now bearing fruit.

How is the issue of water supply impacting the mining sector?

The water issue has stricken all of Chile. We have set the company to work early on every project for desalination and water pipes, and SKIC has worked on both the engineering and execution of several desalination projects. The extremes that we are facing have forced the mining sector to invest all of its know-how, because to tackle a crisis like this, we have to think not just as a company but as an industry.

What is your outlook for brownfield and greenfield mining development in Chile?

I am optimistic because I see that, in the context of high commodity prices, mining investments will continue being long-term. Political headwinds are

often more short term and therefore do not affect us so much. A number of projects have had studies fast-tracked, and there is a lot of brownfield work to adapt production processes to more sustainable methods, which is a trend we see continuing. The role of mining to produce the metals and minerals needed for sustainable energy will create a virtuous cycle, which is particularly relevant in countries such as Chile and Peru.

What is your strategy to consolidate SKIC's position in the market?

Consolidating the company has to go through these steps: demonstrating ethical work, professional excellence, being humble enough to acknowledge mistakes and being willing and able to solve them swiftly. Another point I must highlight is innovation. There is no development or consolidation of any company if innovation is not on the table. That also goes hand in hand with sustainability; innovation is necessary for desalination plants, but also when planning social projects to integrate communities and ensure environmental stewardship. From an HR standpoint, consolidation means not just hiring a person, but thinking about the development of their family and how it supports the industry, the country and the environment. ■

How was 2021 for Echeverría Izquierdo?

Despite the challenges of the pandemic, 2021 was one of the most successful years of our company. With a workforce of up to 9,000 workers, we never halted operations and closed the year with historical results where the mining industry represents more than 60% of our revenue.

During this year, we continued with the construction of the primary crusher at Quebrada Blanca phase 2 (QB2) project and completed some minor scale projects for BHP and CMP. We also continued with the works in MAPA expansion project of Celulosa Arauco, the largest project in the history of the company. Noteworthy to mention was awarding the construction contracts for two major concentrator plants in the last quarter.

The first one is the Rajo Inca project in Salvador, an emblematic project for Codelco, consisting of the upgrade of the concentrator plant and the thickener's overhaul. The second one corresponds to the wet area and the truck shop facilities at the Mantoverde project, where we will start work this year. All of this enabled us to end 2021 with an historic backlog, consolidating our leading position in the mining construction and assembly services.

Can you elaborate on Echeverría Izquierdo's work on the primary crusher at QB2 and at the concentrator plant at the Mantoverde project?

We have been building Teck's QB2 project since 2019. Its scope includes the primary crusher, two overland conveyors, a stockpile, the reclaim tunnels and a lime plant. This project has been a great success, especially for the implementation of innovative solutions such as the post-tensioning technology.

2022 started with the mobilization of Mantoverde Development project, which includes the wet area and the EPC truck shop. Our team has recently finished up the temporary facilities and are hoping to start building soon. We were hired by Ausenco to work in collaboration with them and Capstone, who recently merged with Mantos Copper. We won the contract for the



Darío Barros Izquierdo

General Manager
Echeverría Izquierdo Montajes Industriales



With a workforce of up to 9,000 workers, we never halted operations and closed the year with historical results where the mining industry represents more than 60% of our revenue.



most critical part of the project: the ball mill and the concentrator plant. This is a very important project for us and we look forward to safely delivering and advancing it throughout 2022 and beyond.

What type of work does Echeverría Izquierdo do for lithium projects?

For four years we were working with one of the world's top lithium producers in different EPC and construction projects in Chile, in areas such as the pneumatic transport system, solvent extraction plant, thermal evaporation plant and one step and boron removal plant, working directly with the client to interconnect these plants. The lithium process is much more similar to a chemical operation than a traditional copper plant mining process. For this reason, we assembled a strong team of people with previous experience in refineries and pulp and paper plants, both sectors in which Echeverría Izquierdo has extensive experience.

Echeverría Izquierdo has been recognized for six years running by the Chilean Chamber of Construction for workplace health and safety standards. Which factors contributed to this recognition?

Safety is a core value for us, and we are

proud of being recognized in the honour roll from the Chilean Chamber of Construction for six years. This is an important achievement, but not trouble free, considering our large workforce, the nature of our services and the challenges imposed by the COVID-19 pandemic. A contributor to this recognition is our approach to work with our own people and equipment fleet; we outsource very limited activities, and we work with our own cranes and major lifting equipment. We therefore know their story and maintenance as well as the operator and rigger. We have a centralized Rigging department that has an exhaustive review process to ensure the safe performance of hoisting and rigging activities.

The most important factor is our culture, which we call "the Echeverría Izquierdo Montajes Industriales' way of work". We take care of our people and we are close to them. We have employees who have been with us for more than 20 years, in both the good and the bad times. We have doubled our team in the last years up to 9,000 employees due to of the large mining and pulp and paper projects. Therefore, training our people in health and safety has been a key priority to us, from management to supervisors, foremen, technicians and workers. ■



Tomás Fischer Ballerini

General Manager
EDYCE

What were the main challenges faced by Edyce in the last year, and the company's main accomplishments?

The lack of major investments into Chile's mining industry and the political situation in the country were the main challenges. Because of uncertainty surrounding Chilean politics and the new constitution, most major projects were delayed and some even cancelled.

Despite these challenges, Edyce adapted its organization to remain profitable, and we were able to meet the schedules of all the projects we executed. One of the major projects was Américo Vespucio Oriente Concession's (AVO) El Salto Viaduct project, where we were responsible for the fabrication of the steel structures as well as the erection and innerworkings of the viaduct in one of Santiago's most congested avenues.

From the perspective of Edyce's involvement with the mining sector, what would you like to have achieved by 2023?

Edyce aims to remain leaders in the fabrication and erection of steel structures. We want to position ourselves as an innovative company, rapidly incorporating new technologies and software solutions to achieve greater efficiencies both internally and for our clients. ■



Christian Abt

Area Sales Manager – Americas
MJ GERÜST

Can you introduce MJ Gerüst?

MJ Gerüst is a German scaffolding manufacturer that produces five distinct types of scaffolding models, all produced in accordance to the EN 12811, EN 12810 and certified by the Deutsches Institut für Bautechnik.

Which challenges in the mining sector supply chain does MJ Gerüst intend to help solve?

The mining sector has a huge opportunity to save in costs and improve from the standpoint of its contracting models. MJ Gerüst offers global contracts, by which we supply any contractor with the products on-site. Furthermore, because of our experience with scaffolding, the subcontractor does not underestimate or overestimating the needs of the operation. Finally, on-site supervision is performed by us, as well as blueprint development for each project, and we have the capacity to work with open-book costs, meaning all customers on site receive the same price.

From a mining perspective, where would you like to see the company three years from now?

We are currently moving into larger facilities in Chile, and are in the process of implementing facilities and equipment in Peru. We are also planning to move into Brazil during the second half of 2022. ■



Antonio Carlos Machado

Commercial Director – Chile
ULMA CONSTRUCTION

Can you describe ULMA Construction's range of formwork and scaffolding solutions for concrete?

We have scaffolding systems that greatly facilitate construction processes, designed to generate safe access based on solid engineering studies. In short, ULMA has been present in the Chilean market for almost 30 years and has a wide range of products and facilities in Santiago and Antofagasta, covering more than 50,000 square meters of operations and storage.

What significant milestones would you like ULMA to achieve in the coming years?

We have weekly meetings where we evaluate future projects. Then we prepare the commercial, logistics, and engineering areas to be better positioned to participate, regardless of any disruption in the world.

Today's lack of workforce is one of the biggest challenges at a global level, which is why ULMA uses technologies to generate greater efficiencies and less dependency on labor work. Much more industrial work can be done using machinery and equipment. This is an area of business where we continually grow and hope to become more relevant in the future. From a mining perspective, it can help reduce costs, increase productivity, and improve safety. ■

Can you provide details of the five new Liebherr T264 electric wheel drive trucks deployed by Thies at Antofagasta Minerals' Encuentro Oxides operation at Minera Centinela?

Thies has a strong working relationship with Liebherr that dates back decades. We're excited to bring the new T264 electric-wheel-drive trucks to Chile. The trucks are on site at Centinela and currently (May 2022) in the commissioning phase. We anticipate deploying the trucks in the upcoming weeks. This investment reinforces our commitment to Chile, an important part of Thies' growth plans in South America.

How is the Hydra consortium, including Thies, working to replace the use of diesel in high-tonnage vehicles with hydrogen?

The Hydra consortium is looking into alternative fuels, such as hydrogen, and fuel combinations like hydrogen-electric. Thies' involvement in the developmental project is part of our commitment to drive more sustainable mining practices. We are also involved in other initiatives, exploring alternative fuel sources that could serve as a catalyst to reducing the carbon footprint of our own fleets and allowing us to help clients reach their own carbon emission reduction goals.

The cost of fuel has been a significant challenge over the last year. To counter this, we have worked to maximize operational efficiency, minimizing idle time, or non-effective uptime, with our fleet. Thies is currently participating in trials to reduce diesel fuel consumption in Australia, which could also have a significant impact.

Can you give examples of the latest innovations Thies is working with which are improving productivity and increasing safety at mine sites?

Technology plays an important role in improving both safety and productivity, which go hand in hand. Statistically, operations with the safest workplaces are the most productive. Technology supports the decision-making process of workers, and at the end of the day, it's still people who operate equipment and make decisions on site. Our approach is to combine technology with training to aid transformation in mining, which is increasingly important as



Darrell White

Executive General Manager – Americas
THIESS

↘↘
Our approach is to combine technology with training to aid transformation in mining, which is increasingly important as we see ore grades decline.
↙↙

we see ore grades decline. Autonomy also plays a role in this. For example, Thies operates autonomous and semi-autonomous dozer and drill fleets in Australia, and later this year, we will deploy our first autonomous truck fleet, also in Australia. We are seeking out the right opportunities with the right clients in Chile to deploy similar technologies here, which will help reduce the number of people on site, particularly in high altitude areas.

What is Thies's approach to fostering strong social relations with local communities and attracting a more diverse workforce?

Focusing on improvement through ESG initiatives is crucial to the success of the mining industry. Many of our employees come from the outlying communities in which we operate and, as a company, we must be good stewards by offering fair, healthy and sustainable working conditions and development opportunities for our people. Furthermore, as an industry we have a responsibility to ensure enough of the benefits earned from mining serve the communities and countries that generate them. In northern Chile Thies participates in scholarship programs to train locals and equip them with the tools and skills they need to gain sustainable employment and support their families.

We have made a dedicated effort to train women in the north of Chile, including a multi-year apprenticeship program, which we are initiating in 2022 in partnership with local technical institutes. Later this year, Thies will open a new innovation, training and technology center in La Negra, Antofagasta, which will focus on preparing skilled maintenance personnel. The facility will also serve as an operational training center with technologies that can help develop new skill sets

What are the main themes you see impacting the mining services segment in 2023?

Thies' new vision, launched in May 2022, outlines our commitment to developing our people, utilizing new technology, and driving the industry toward more sustainable resource solutions. We see alternative fuels play a key part in this transition and are actively working to minimize our carbon footprint.

Another major shift comes from the implementation of autonomous equipment to increase safety on site by removing operators from high exposure mining environments. This creates a workplace with greater fatigue management and supports retention through opportunities to upskill and work with the latest technology in the industry. ■

How would you evaluate the performance of STRABAG and ZÜBLIN in Chile in 2021 and Q1 2022?

We have taken part in projects of the highest technical standard. Indeed, milestones such as the completion of the 74 km of tunnels of the Alto Maipo hydro-electric project, which is the largest project of our company to date, has allowed us to extend our scope in Chile and participate in projects such as the Horizonte Wind Farm in Tal Tal, where we took over the civil works, or the construction of a 673 meters ventilation shaft in Chuquicamata, among many other.

During this period, the pandemic also added other administrative challenges, which impacted our business, such as logistics, shift planning, or tracing contagions among over 7,000 people, but we managed these challenges in close collaboration with our clients and the quality of the works was not affected. I am convinced that our appreciation towards our great teams with open, transparent communication and our customer centricity are key to success, and it explicitly helps during a pandemic.

What are some of the technical challenges of working on large-scale projects such as Codelco's El Teniente and Chuquicamata?

Currently the main challenges in these projects are related to geology, training and logistics.

Risks related to rock burst or seismic activity are common in underground construction, which is why we have engaged in a tele-commanded machinery program in El Teniente -a mine which is particularly seismic-, so we can operate machinery from outside of the tunnel, keeping our personnel safe.

Also, providing training and inductions to thousands of people is a complex task. This includes maintaining the outstanding health and safety standard that we proudly hold today.

In the field of logistics, there are several different contractors working together in a limited underground area, usually using the same access tunnels. Addressing this requires good coordination among all contractors and the client.

In underground mining projects such as Chuquicamata and El Teniente, we focused on exceeding the expected yields and rates, with all the interferences of working in a confined space. Yet we achieved monthly advance rates of up to 1,800 meters (1.1 miles) in Chuquicamata and 900 meters (0.55 miles) in



Mario Theurl

General Manager
ZÜBLIN STRABAG CHILE

↘↘
I am convinced that our appreciation towards our great teams with open and transparent communication and our customer centricity are key to success.
↙↙

El Teniente, even under the pandemic restrictions.

Can you give examples of the remotely operated equipment that is improving efficiency and safety at underground mining operations?

We have equipment to install mesh and bolts for fortification without people having to approach into areas without rock support, or we have equipment like remote controlled loaders to remove rocks from a recently blasted area. We also have a device which can enter the mine and take images to create a 3D model of the interior.

How is digitalization impacting the underground mining industry, and how can it be implemented most effectively?

We are currently going through a big digitalization wave and a significant number of resources are coming to the market which simplify our jobs and raise productivity. I am convinced that in the long term, the megatrend of digitalization will give our industry the necessary and overdue boost to advance work processes and increase productivity hand in hand with the improvement of H&S standards. The challenge on short term now is to evaluate these tools and find the right ones that can truly help to increase customer value, optimize operations, and increase safety. With so many products on the market today, and many still on their way, we have noticed that it

can be a challenge for people to effectively adopt and learn, as technologies are moving sometimes too fast for people to properly digitize their operations. Without being able to effectively adopt and learn, we could be prone to errors that may cost money and result in delays. I therefore believe it is important to increase our focus on selection of different digital tools and to look at what is really helping us in terms of safety, productivity, and cost in the short and long term, and then adopt the right developments for each operation to advance ourselves and the industry. No project should add digital tools just because they are digital – technology must fit the organization and our clients' priorities with the aim to advance our industry.

How is Zublin dealing with the challenge of attracting and retaining a skilled local workforce?

We value diversity as much as we value skills. We are very proud to be an international and multicultural team because it allows us to share vast knowledge and many different points of view. Our goal is to convene people sharing this view and our Teams Work philosophy.

Our company provides continuous and focused training, aiming to prepare our teams for the present and the future. These trainings include among others safety inductions, a variety of technical skills, machinery operation and Lean Construction. ■

Going Underground

Enabling Chile's transition from open-pit to underground mining

Declining ore grades in Chile have caused a steady decrease in total factor productivity (TFP), increasing the cost of open-pit mining incrementally. This is driving the country's mining sector underground. The poster child for such developments is Codelco's Chuquicamata, where the State-run mining company is spending over US\$5.6 billion on to transition the century-old mine from one of the world's largest open-pit mines (by excavated volume) to an underground operation to maintain production rates and extend the life of mine by over 40 years.

The large copper-gold porphyry systems scattered across the Andes often start with an oxides layer on top of a higher-grade sulfide level at depth. The development to

transition large-scale mines from open pit to underground operations usually involves large capex, which offers opportunities for companies involved in the raise boring and tunneling space. Furthermore, raise boring's importance for ventilation of the exhaust of diesel-operated equipment within mines make it a necessary expense for older operations such as El Teniente, the largest underground mine in the world.

Master Drilling, a vertical development specialist and leader in raise boring and blind hole boring (a mechanized alternative for conventional methods which allows for the development of block caving) has contracts at both Chuquicamata and El Teniente. Fernando Vivanco, Master Drilling's general manager for Chile, discussed the company's new technology called MTB (mobile tunnel borer) for mechanized horizontal development, which is currently in South Africa undergoing tests. "We have had preliminary conversations with Codelco to test the machine in Chile, and they are interested in going to South Africa to see the machine and establish if there is a possibility to bring it to this country for testing," he revealed.

Elaborating on the technology, Vivanco explained how MTB is like a TBM (tunnel borer machine), but mainly focused on mining. "Whereas traditional tunnel borers are focused on civil works, the MTB is a bespoke machine for mining to allow for horizontal mechanical excavation for underground mining development and can operate on a 12-degree incline or decline development," he said, noting that the machine can be utilised to excavate a variety of tunnels, including tunnels to underground ore bodies such as declines, portals, haulages, inclines, ramps, ring roads and connecting tunnels.

American company Robbins is one of the pioneers in the TBM market, celebrating its 70th anniversary in 2022. Lok Home, president and CEO, provided details of how the company's Mine Development Machine (MDM) 5000 is specifically designed for underground mechanical excavation, like a TBM, but for mining applications. "Historically, 99% of TBMs have made a round tunnel which is not a good shape in the mining industry as miners use vehicles to extract the ore. Robbins' aim was to give miners access tunnels using mechanical boring means, but with a flat floor and good ground support," he explained, adding that the MDM can make a tunnel much faster than what can be accomplished with mechanical drill and blast.

Emphasizing the importance of mechanization in the drive towards automation, Home observed that mining companies are starting to realize that the only way to go to mechanized mining underground is to accept mechanical excavation. "We are already seeing more demand coming from industry rather than us trying to chase them," he revealed, continuing: "We also foresee that in the next 10 years we will actually be mechanically excavating ore bodies. Although this trend might be slow to take off, we expect huge demand in the future. Environmental consciousness is also driving the trend towards underground mining and mechanical excavation as nobody wants to see big open pits and piles of tailings."



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With underground tunneling comes a myriad of challenges such as space constraints, difficult ground conditions, unmovable underground structures, and work that must be done in an environment where it is difficult to deploy reliable network systems. Rajant's private wireless network enables tunneling operators to overcome these inherent networking challenges.

- Sagar Chandra,
Vice President Business
Development - Americas,
Rajant



Tecnological advancements

Some of Chile's most important mining operations are also the oldest. Mining at El Teniente, for example, is reported to have started as early as 1819. Introducing technology at operations that have operated in a certain way for many years can be a challenge, but State-run mining company Codelco has invested heavily in modernizing its operations. Speaking at the World Copper Conference, CEO Octavio Aranedo underlined the company's focus on digital transformation.

César Ortega, founder and general manager of Chilean company Telemining, worked at Codelco for 34 years and became director of telecommunications, information and automation technologies for all divisions before founding Telemining in 2011. Telemining provides digital services, installations, automatization and access control systems for underground mining settings, and Ortega emphasized the importance of installing the requisite digital infrastructure to support autonomous operations. "Today a 1 GB network is too small; you need at least 10 GB to communicate between camps," he stated, noting that the demand for communication networks has never been higher. "Broadband communication is a must, because shovels and trucks are now automatic. That is the tendency of the future where mining will become completely automated; all the operations will be driven and managed from control rooms through broadband communication networks."

Telemining has worked with Rajant at El Teniente, a US-based company focused on enabling wireless communications in real time. Sagar Chandra, vice president business development Americas at Rajant, explained that with underground tunneling comes a myriad of challenges such as space constraints, difficult ground conditions, unmovable underground structures, and work that must be done in an environment where it is difficult to deploy reliable network systems. He described how Rajant's private wireless network

enables tunneling operators to overcome the networking challenges inherent in enabling communications, and improves productivity inside tunnels: "Our Kinetic Mesh network comprises compact, lightweight BreadCrumb nodes that can be flexibly deployed throughout the tunnel, on both fixed infrastructure and moving equipment, to form a robust mesh network underground."

In July 2021, one of big four global OEMs, Sandvik, completed its acquisition of DSI Underground, with DSI becoming part of Sandvik's Mining and Rock Technology division. Carlos Leigh, DSI Underground's regional CEO for Latin America, affirmed that the integration of the companies had progressed as planned, and that DSI will maintain its operational independence, but now with the weight of a major OEM behind it.

Leigh highlighted Codelco's PMCH (Proyecto Mina Chuquicamata Subterránea) as one of DSI's most important projects, where the company supplies underground support and ventilation products. Ventilation is one of the biggest costs in underground operations, and Leigh spoke about how DSI's joint venture with ABC Technology Group is optimizing this process: "One of the most important innovations (of the DSI-ABC JV) is HardLine, a new duct made with a high resistance semi-rigid plastic that replaces steel ducting in some cases," he said, adding that it is easy to install, has much better ventilation capabilities than steel, and will soon be produced locally in Chile, reducing extra costs related to freight and improving delivery times considerably, a critical issue for customers. ■



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with mines in mind,
capable of boring long
drifts and access
tunnels at 10-12 m/day
in hard rock.

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What are some of the standout projects that Master Drilling is working on in Chile?

Master Drilling is a vertical development specialist. We currently hold six contracts at the El Teniente mine, acting as a vertical development expert alongside the main contractors. In addition, we have presence at the Chuquicamata copper mine through a joint venture between Master Drilling and Besalco, where we are engaging directly with Codelco.

Our services at El Teniente and Chuquicamata include raise boring as well as blind hole boring (also a vertical development, for which Master Drilling is the leader in Chile). We are the main vertical development contractor in Chile with currently 12 blind hole machines and eight raise bore machines in our fleet.

Can you elaborate on Master Drilling's new MTB (mobile tunnel borer) technology?

Master drilling has developed an extremely interesting technology called MTB (mobile tunnel borer), for mechanized horizontal development, which is currently in South Africa undergoing tests. We have had preliminary conversations with Codelco to test the machine in Chile, and they are interested in going to South Africa to see the machine.

Whereas traditional tunnel borers are focused on civil works, the MTB is a bespoke machine for mining to allow for horizontal mechanical excavation for underground mining development and can operate on a 12-degree incline or decline development. It will be a huge opportunity for us if we can bring this technology to Chile as the machine can be utilised to excavate a variety of tunnels, including tunnels to underground ore bodies such as declines, portals, haulages, inclines, ramps, ring roads and connecting tunnels.

What does blind hole boring involve and what expertise does Master Drilling have in this field?

Raise boring happens in two phases – a pilot hole is drilled from an upper level to an underground cubby or tunnel, whereafter a hole is then cut from the underground tunnel or level to the



Fernando Vivanco

General Manager – Chile
MASTER DRILLING

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We are the main vertical development contractor in Chile with currently 12 blind hole machines and eight raise bore machines in our fleet.
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upper level. Often, due to production methodologies, you are not able to bore both levels in the same way. Blind hole boring is a mechanized alternative for conventional methods. This methodology can facilitate access and establish shafts of up to 2.1 m in diameter and up to 90 m length in hard-rock applications where raise boring methodology is not feasible.

Master Drilling Chile is the leader in blind hole boring technology. We do blind hole drilling mainly for slots, to create an open space which will allow the development of block caving. We are mainly drilling at 1.5 m, but over the past year, Codelco has requested to increase that diameter to 1.8 m and in some cases even 2.1 m.

How has demand for your business evolved in the last two years considering the restrictions for underground mining contractors during the pandemic?

2020 and 2021 were quite tough as there were many restrictions and limitations placed on mining activities due to the pandemic. We never completely stopped operations and continued to work on our projects with the right protocols and measures in place. In 2022, we have now returned to almost a normal pace of working with just a few restrictions still in place. A posi-

tive coming from the pandemic was the acceleration of technology and digitization, and the administrative part of business has become more productive.

Is price or quality a bigger concern for clients in today's climate of high metals prices?

Price remains important to clients. The challenge is to demonstrate to clients that often it is better to pay a bit more, but to receive added value. Being a solutions provider, ensuring value add and increased productivity for our customers, they understand that the price might be a bit higher than only paying for a specific service, but they are paying for quality.

What are the main competitive advantages of Master Drilling?

Master Drilling's is focused on bringing the best technology, innovation, and productivity to our customers. Our focus in Chile is to be a solutions provider more than just a service provider as we want to be a partner for customers, solving their complex issues. We manufacture our own machines and components, so we can respond to new industry requirements, and we also have our own training center where we are developing talent to be able to meet the growing demands of our customers in the years ahead. ■

How does Robbins' Mine Development Machine (MDM) 5000 underground mechanical excavation equipment work?

The MDM is specifically designed as a mechanical excavation machine, like a TBM, for mining applications. Historically, 99% of TBMs have made a round tunnel, which is not a good shape in the mining industry as miners use vehicles to extract the ore. Robbins' aim was to give miners access tunnels using mechanical boring means, but with a flat floor and good ground support. We thus developed the MDM, which is in effect a TBM designed to achieve a flat floor, which can make a tunnel much faster than what can be accomplished with mechanical drill and blast.

What trends have you noticed as mines transition to underground operations?

Mines have to mechanize in the drive towards automation. Without mechanized boring you continue to drill and blast everything, which is a long hard chore. Mining companies are starting to realize that the only way to go to mechanized mining underground is to accept mechanical excavation. We are already seeing more demand coming from industry. We foresee that in the next 10 years we will actually be mechanically excavating ore bodies. Environmental consciousness is also driving the trend towards underground mining and mechanical excavation as nobody wants to see big open pits and piles of tailings.

What are some of the standout mining projects Robbins has been involved in?

In my early days at Robbins, we utilized massive raise boring machines in a number of mines. More recently, the company worked with Stillwater Mining in Montana, where we sent in four round TBM machines for advanced exploration. Approximately six years ago, we did an incline for a coal mine in Queensland where we started from surface, bored down to the coal seam, extracted the TBM from the first heading, and then moved it over into another heading. This was an extremely successful project as we used our civil engineering and mixed ground experience going from surface to water bearing soils



Lok Home

President & CEO
ROBBINS TBM

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Robbins is known for taking on challenges – navigating bad conditions and getting out of them – and that is what we are going to continue to do.
↙↙

to hard rock to the ore body in an extremely fast way.

Can you tell us about Robbins' involvement at the Los Condores Hydroelectric Power Project in Chile?

The project did not go 100% as intended because the geological horizon of the power plant was not defined enough and when we brought in the machines to bore the tunnels, there were more geological difficulties encountered than expected. Robbins, Enel and the contractor worked well together to work through the more difficult conditions and the two machines we supplied worked well.

Robbins also worked on the Olmos Trans-Andean Tunnel. What are some of the main challenges when tunneling in the Andean region?

In high mountain tunneling you have significant high cover above you, which means the rock stress changes – the deeper you go the more the stress. Rock stress changes usually end up in rock bursting and groundwater can also be a challenge. The fact that we had to finish the Olmos tunnel even when rock burst conditions were horrendous was quite challenging but the project was successful. I believe that today we are ready to take on any condition as we can address high stresses, heat, and water inflows.

What type of partnerships are you looking for with mining companies and contractors?

We are not equipment suppliers and are looking to take on a partner role with mining companies and contractors. Just because the mining contractors are very used to drill and blast, part of the partnership has to involve bringing in the expertise of mechanical excavation to refine expertise and ensure success.

Robbins celebrates its 70th anniversary this year. What have been the key factors behind the company's longevity?

Robbins has always been at the forefront of innovation in the industry. On the civil side, we were the first to invent modern TBMs in 1952, and then we moved into innovating for mines with raise boring and non-circular excavation solutions. Innovation is critical. It involves risk, but you have to take on challenges to continue moving forward. Robbins is known for taking on challenges – navigating bad conditions and getting out of them – and that is what we are going to continue to do. The idea of innovation is a collaborative thing, and we have the willingness to work with mines and contractors to develop solutions that are not yet in the marketplace. ■



“The role of mining suppliers has become more of a partnership than before, given the scarcity of labor and tools as well as supply chain disruptions. Miners understand that they cannot do everything themselves and thus need to partner with complementing companies.”

**- Ricardo Garib,
President,
Weir Minerals**

EQUIPMENT & TECHNOLOGY

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Image courtesy of Weir Minerals

The Evolution of Mining Equipment

This rise of autonomous mining and remote operations

Three of the fundamental challenges facing the mining sector revolve around decreasing its environmental impact, mining lower-grade deposits more productively, and accessing new deposits. Long before the pandemic, declining ore grades had been the stimulant to develop technology that could lower the cost per pound produced and increase the safety of extracting metal. Covid-related work-from-home restrictions accelerated the adoption of remotely operated equipment and now, in 2022, inflationary pressures and supply chain delays have added further tests. The industry is undergoing a transformation to ensure it remains competitive from both a cost and ESG standpoint.

Autonomous mining and remote operation are two of the key themes enabling the sector to address these issues. Teck's Quebrada Blanca 2 (QB2) will be the first of the company's operations to incorporate a remote Integrated Operations Centre (IOC), bringing together the resources and data necessary for centralized decision making to help achieve better operational performance. Furthermore, being based in Santiago, the IOC can attract a new generation of mining professionals who may not want to be located at the mine site.

"As QB2 is a greenfield development you can build the autonomous operation as the customer is building the mine. You have the benefit of being able to establish a cul-



I believe the era of siloed competition is behind us. Collaboration, not only amongst business partners, but also between competitors, is vital to deliver the solutions that the world needs and our customers need.

- John Swift,
Managing Director – Chile,
Epiroc



ture from scratch and you can build a team which is centered around this new way of operating," observed Sebastián Guridi, senior VP of mining – South America at Finning.

In 2019, Finning signed a contract with Teck to supply a fleet of Caterpillar 794AC electric drive off-highway trucks and other large mining machines for QB2, as well as Cat's Command for Hauling system and 794AC AHS (Autonomous Haulage Technology) kits. "One of the most valuable things about the QB2 project is that we are demonstrating that we can successfully do autonomous mining in deep, hard rock copper mines at 4,000 m of altitude," said Guridi, adding that autonomous vehicles also help in reaching areas which would otherwise not have been accessible.

Guridi believes that autonomous hauling is a real game changer for the industry, giving the example of Finning's autonomous underground equipment being used at Chuquicamata, El Teniente and Candelaria: "Everything can be done autonomously with only small sections which require manned operations, allowing you to have one operator for several vehicles."

Darko Louit Nevistic, CEO of Komatsu Cummins Chile, discussed the Komatsu Front Runner Autonomous Haulage System (AHS): "The architecture of Komatsu's system will allow for true interoperability in the future so that many machines, including eventually other OEM's systems or autonomous vehicles, will be able to connect to our central control that supervises the complete mining operation."

Nevistic explained that Komatsu's current solution utilizes MMS Dispatch system for optimization, which is integrated with the latest versions of Front Runner and manages machine control and supervisory functions. "With these features, mining customers can optimize their operations, increasing safety and predictability, which allows for longer running time, maximized utilization of equipment and lower maintenance costs, ultimately leading to lower cost per ton," he said, adding that the AHS also generates very reliable information from the operation itself, allowing mining companies to continuously improve their efficiency and productivity."

Gonzalo García Pérez, general manager of Liebherr Chile, mentioned that all the company's trucks are available with a Trolley Assist System, providing a low emission solution for customers. "The Liebherr Trolley Assist System is an effective first step on the road to zero emission mine



Image courtesy of Kinross

sites of the future," he said, explaining that the system utilizes an overhead pantograph of trolley bars to connect the electric-drive system to the electrical network.

"The Trolley Assist System offers increased truck fleet productivity, or reduction in fleet size, while maintaining yearly production when compared with standard trucks. A significant reduction of diesel fuel consumption is also made possible with the Trolley Assist System along with a reduction of the truck fleet CO2e emissions," revealed García.

John Swift, Epiroc's managing director for Chile, highlighted digitalization and the company's automated suite of products as areas of the business that have been in high demand. He gave the example of Epiroc's involvement at Anglo American's Los Bronces project where automated Pit Vipers are operated from a distance. On the subject of innovation, Swift revealed that Epiroc is looking at remotely doing tasks not only operating the machines: "For example, cognitive reality, where we can advise technicians from a distance, and micro-adjustments to pumps and motors to keep people away from physically running the machines."

Swift underlined the importance of collaboration between suppliers, such as such as Epiroc's work with Chilean company, ROCMIN Servicios Mineros to create equipment that is customized to suit Chilean conditions: "I believe the era of siloed competition is behind us. Collaboration, not only amongst business partners but also between competitors, is vital to deliver the solutions that the world needs and our customers need."

Ancillary vehicles

Suppliers of ancillary and construction vehicles, such as the trucks and tipplers that move ore, dirt and concentrate, or the buses that transport mining workforces, have seen rejuvenated demand since the height of the pandemic.

To keep up with demand from mining in the Antofagasta region, Swedish OEM Scania has decided to invest US\$5 million to expand its workshop, with construction due to start in September/October 2022, according to Pascal Zappone, managing director of Scania Chile. When asked about the focus of this demand, Zappone pointed to solutions that increase the sustainability of operations, such as fleet managements systems (FMS) that enable customers to utilize data from a connected vehicle, lowering fuel consumption and reducing wear and maintenance needs.

Zappone highlighted Scania Super, a new engine platform that will be launched at the end of 2022: "This new powertrain has sustainability at its core and is the most advanced combustion engine we have ever built, promising a reduction in fuel consumption of between 8% and 10% and more uptime than ever before. All engines have inherent HVO (hydrotreated vegetable oil) fuel capabilities, and two of them can be ordered as FAME biodiesel versions."

Luis Izquierdo, general manager of Andes Motor, the equipment distributor that represents Maxus, Foton, Karry, Iveco, Agrale and Sany in Chile, spoke of the progress made in electric vehicle adoption for mining passenger transport, which Andes Motor is advancing with SQM and Teck. He detailed that the company's sales in the EV area increased by 44% in 2021, and revealed the company will be testing electric tractors at mine sites in 2022.

Discussing the challenge of transitioning to electric mobility because of the significant technological change, Izquierdo added: "We created a specific electromobility unit to grant support to customers and help them learn. In the same way we went to factories to learn; we have to transmit that knowledge to advance adoption." ■



The interesting thing about Andes Motor's proposal in terms of electromobility is that today it is not just about selling an electric vehicle, but rather delivering an integral solution that includes an entire ecosystem that will allow the operation of these vehicles, from the charging system to a GPS system."

- Luis Izquierdo,
General Manager,
Andes Motor





Sebastián Guridi

Senior VP of Mining – South America
FINNING

Which of Finning's autonomous underground mining technologies is gaining traction?

Autonomous hauling is a real game changer. Everything can be done autonomously with only small sections that require manned operations, allowing you to have one operator for several vehicles. The benefit of autonomy is not only increased efficiency, safety, lower costs and decreased emissions, but autonomous vehicles also help in accessing areas which would otherwise not have been accessible.

Can you describe Finning's involvement at Teck's QB2 project?

As QB2 is a greenfield development so you can build the autonomous operation as the customer is building the mine. You have the benefit of being able to establish a culture and you can build a team which is centered around this new way of operating. We have an excellent relationship with Teck as they share many of Finning's values, especially how we use technology to become more efficient and create more value.

One of the most valuable things about the QB2 project is that we are demonstrating that we can successfully do autonomous mining in deep, hard rock copper mines at 4,000 m of altitude. I believe that this project will remove many barriers to have more autonomous operations in Chile and will give a completely different shape to the mining industry over the next 10 years.

What is the company's capacity to repair, upgrade and provide spare parts in Chile?

Repair and maintenance are becoming more relevant as you see strong commodity prices, in particular copper.

Finning will rebuild anything that makes sense economically. For example, we are currently rebuilding 495HR/7495 electric rope shovels, 793F trucks, and D10 and D11 dozers. This was an area of business I saw grow a lot as senior VP of mining for Finning in Canada, and I believe that there is room for more upgrades and repairs in the Chilean market to ensure the industry gets all the value it can from its assets. ■



Darko Louit Nevistic

CEO
KOMATSU CUMMINS CHILE

Can you explain how Komatsu's Autonomous Haulage System (AHS) improves the productivity of a mining operation?

The Komatsu Front Runner Autonomous Haulage System (AHS) consists of controllers both at the vehicle level, and a complete supervisory logic in a central control. The architecture of Komatsu's system will allow for true interoperability in the future so that many machines, including eventually other OEM's systems or autonomous vehicles, will be able to connect to our central control which supervises the complete mining operation. We believe in an open architecture for data so that customers can maximize the value across their organization. The AHS also generates very reliable information from the operation itself, allowing mining companies to continuously improve their efficiency and productivity.

Can you elaborate on the GHG (Greenhouse Gas) alliance launched between Komatsu and major mining companies?

High-horsepower vehicles such as haul trucks represent the largest source of emissions in a mining operation, at approximately two thirds, so Komatsu has

launched the GHG (Greenhouse Gas) alliance to accelerate the deployment of lower and ultimately zero emission mining trucks within the remainder of this decade. In this alliance we are working with several global mining customers, including Codelco, AMSA, BHP, Rio Tinto, Boliden and Kinross. Komatsu has developed the idea of power-agnostic trucks that, from the original design, have the possibility of changing the power source, as technology advances and new alternatives become available. We understand that the lifespan of a truck is around 15 years, which is a long time when technologies evolve fast.

What is the company's capacity to repair, upgrade and provide spare parts in Chile?

We have three component repair centers in Chile, in addition to two high horsepower diesel engine rebuild centers managed by Cummins Chile. We are building a new facility in La Negra, near Antofagasta and right next to the KMC Repair Center, where our current Antofagasta Komatsu Reman operations will move into at the end of 2022, to increase capacity. ■



John Swift

Managing Director – Chile
EPIROC

Which of Epiroc's technologies were in high demand in 2021, and can you provide an example of an autonomous mining project you have recently been involved in?

Our digitalization and automated suite of products has been in very high demand. This has typically been in the surface drilling market for both production and contour drilling, however we are seeing expansion in the autonomy side.

We work on the Los Bronces project with Anglo American, where automated Pit Vipers are operated from a distance. We are also taking the step into remote operation of multiple types of equipment, whereas historically it had been one type of equipment.

Are there any particular features of Epiroc's equipment that you would like to highlight?

We are looking at remotely doing tasks, not only operating the machines. For example, cognitive reality where we can advise technicians from a distance, and micro-adjustments to pumps and motors to keep people away from physically running the machines.

I was with Anglo American last week and got to meet one of the operators that works on the autonomous fleet. I asked him very pointedly, 'what is one thing that Epiroc could do to make your life better?'. He responded simply, 'nothing', which was an incredible answer for me. Here this young operator had the opportunity to ask for anything, but he was content with his work life, in the knowledge that he can go home to his family safely.

What are your priorities at Epiroc Chile in the years ahead?

I would like to become even more customer-obsessed with Epiroc Chile, to help them create the solution that they need. This is particularly important in this era of change, whether that change is related to politics, sustainability or the supply chain.

I believe the era of siloed competition is behind us. Collaboration, not only amongst business partners but also between competitors, is vital to deliver the solutions that the world needs and our customers need. ■



Gonzalo García Pérez

General Manager
LIEBHERR CHILE

Can you provide examples of the stand-out mining projects Liebherr has been involved in recently in Chile?

We are currently in an advanced stage for a Trolley application project, a technology that Liebherr has already implemented in two operations outside of Chile, exceeding 40 trucks in operation of 400-t.

Already for a couple of years, we managed to bring the largest hydraulic excavator of our line (R 9800 of 44 m3), which, due to its advanced development, has exceeded our expectations regarding the low fuel consumption.

Once we have installed our first Trolley equipment, we want to test our operator assistance system in Chile. This innovation is available for truck models T 264, T 274 and T 284 and corresponds to advanced design on-board applications that facilitate equipment operation, making them more efficient through automatic functions, leveraging high-precision GPS and RFID (Radio Frequency Identification) technologies.

What progress has Liebherr made in the electric vehicle market?

Liebherr Mining has developed and offered electrification solutions for many years and has now achieved its first tar-

get to offer low carbon emission solutions for its complete digging and hauling range.

Today, Liebherr Mining is the OEM that offers the largest range of electric driven excavators on the market, ranging from 130 t to 800 t. Liebherr also offers complete retrofit options for existing machines in the field.

All Liebherr trucks are available with Trolley Assist System, providing a low emission solution for customers.

How is Liebherr working to lower the carbon output of its vehicles?

Liebherr is targeting to offer completely fossil fuel free mining equipment for hauling, digging, and dozing by 2030. This development focuses on near-zero GHG emissions from well-to-wheel, that is, CO2 emissions from the fuel production to the fuel consumption.

Can you give details regarding Liebherr's partnership with Hexagon?

Integrating the power of Hexagon technologies with Liebherr's state-of-the-art autonomous solutions offers higher levels of on-board intelligence, with reduced reliance on site infrastructure and centralized monitoring systems. ■



Pascal Zappone

Managing Director
SCANIA CHILE

How significant is Scania's presence in Chile?

Scania has a strong network in Chile with 15 branches of our own and 16 tier-one workshops within our customers' facilities. We are also in the process of opening two new branches, including one in Antofagasta to be even closer to mining clients. Scania currently holds the number two position in the overall market, progressing from a 12% market share to a 16.8% market share in the last two years. We sold 1,692 trucks in this period, of which the mining sector represents between 12% and 15%. We are the market leaders for delivering buses to the mining industry with a market share between 35% and 42%. The company sold approximately 300 buses in 2021, of which 50% went to the mining sector.

As an organization, Scania has a department 100% dedicated to the mining sector to develop new products with the required specifications for mining applications. In Chile, we also have teams which are fully dedicated to mining activities.

Which of Scania's smart solutions leverage data to improve performance?

We offer a Fleet Management System (FMS) which enables customers to utilize data from the connected vehicle. This is a great alternative for customers with mixed fleets who already use other telematics systems as it offers access to full fleet data in a standardized format and enables integration with existing systems. Through smart technologies, advanced sensors and wireless connectivity we can obtain data which will not only improve our engineering, but lets us create offers for our customers providing them with direct business value from lowering fuel consumption to reducing wear and maintenance needs.

What new products is the company looking to launch in 2022?

At the end of 2022 we will launch a new engine platform called Scania Super. This powertrain has sustainability at its core, promising a reduction in fuel consumption between 8% and 10% and more uptime than ever before. ■

Can you provide an overview of Cummins Chile and the company's organizational structure?

Cummins Chile has over 70 years' history in this market, and today we have 13 branch offices, 2 Master Rebuild Centers and presence in over 21 mining sites. Our key focus revolves around the distribution and commercialization of a wide variety of products and services for the maintenance and repair of engines and generators, that go from 2.8 liters up to 95 liters.

How can Cummins help minimize expenditure for clients?

Truck fleets in mining are one of the biggest consumers of diesel fuel. Cummins can contribute to optimizing fuel use through technology. Advances in connectivity and automation have allowed us to transform operations, make them more intelligent and efficient, needing less repair time and using predictive analysis to mitigate unforeseen circumstances.

How have alternative fuel generators and green-powered engines been growing in significance?

Innovation is critical to Cummins' sustainability strategy and we are proud to announce that Cummins has the first unified, fuel-agnostic engines. These platforms will use engine blocks and core components that share a common architecture and will be optimized according customer needs to a different low-carbon fuel types.

In Chile we are working very closely with a Belgian company, experts on hydrogen. They helped us to develop a few cases that have demonstrated that hydrogen projects for mining feasible, which will progress implementation at mine sites in the future.

What are the main objectives of Cummins Chile for the next two years?

Cummins' principal goal is to continue to be the first choice for our customers. As we face an energy transition, this challenges us to look at our business model, be closer to our clients to help enable change and meet their specific needs by identifying which of our solutions can be their best option. Collaboration with our partners, including Komatsu, is another key area. Finally, we will continue to focus on our people, strengthen teamwork and integrity, and promoting diversity and inclusion as a value by being an employer that helps talent to develop and grow. ■



Miguel Flores

General Manager &
West South America Leader
CUMMINS CHILE



Comminution & Material Handling

Optimization of production processes is key to reach sustainability targets

Image courtesy of Valmet

It is hard to overstate the importance of comminution – the blasting, grinding and crushing of ore – to the mining value chain. Brownfield investments have dominated Chilean mining development in recent years, as companies invest heavily to increase output, access deeper and lower-grade reserves, and optimize their production processes to take advantage of high copper prices.

In 2020, the merger between Finnish giants Metso and Outotec created one of the leading mining suppliers in the world, with solutions across the entire mineral processing line. Eduardo Nilo, Metso Outotec's president – South America, revealed that the company has seen growth of 15% to 20% business volume in the region, despite challenges such as Covid, supply chain delays and the Ukrainian situation, and that the consolidation period is now complete.

In October 2021, Metso Outotec won a major in-pit crush and convey solutions (IPCC) order from Codelco's Radomiro Tomic Óxidos project. Nilo explained that Codelco seeks to give continuity to the open-pit mining operation at Radomiro Tomic for the exploitation of its sulfide and oxide reserves, operating its SX/EW leaching plant until 2030. To keep the mine operating in oxide extraction during this decade pending the completion of the sulfide project, it is necessary to access reserves that are below or near the current facilities. "This is where Metso Outotec will play a crucial role, supplying Codelco with an EPS (Engineering, Procurement and Services) project that includes the installation of an 11,000 t/h semi-mobile crushing station with a state-of-the-art rotary primary crusher, a Superior MK III 60110, next to the pit mine, which is in production."

Providing further details, Nilo revealed that the solution includes, in addition to engineering and the crusher, an Apron Feeder discharge, an intermediate transfer belt, electrical rooms, dust suppression systems, field assistance service and the extension of the overland sulfide belt by 530 m. He added: "It is also important to highlight that the crushing station is part of Metso Outotec's Planet Positive sustainable solutions, since its operation will mean a reduction of more than 30% in CO2 emissions at the project."

The level of emission reduction achieved by Metso Outotec's IPCC solutions at Radomiro Tomic is a pertinent point. Comminution is the most energy intensive process in mining, accounting for approximately half of the energy used

in the mining sector according to the Coalition for Energy Efficient Comminution, and 4% of the world's total electrical energy consumption. It is therefore an area where companies can make one of the most tangible differences to their sustainability goals.

Another of the major global players in the comminution and material handling space is Weir Minerals, whose president, Ricardo Garib, underlined the importance of sustainability and ESG in the mining sector, particularly under the new environmentally-focused Chilean administration. He gave examples of how Weir can help mining companies optimize their operations: "Weir has developed and improved a technology called High Pressure Grinding Rolls (HPGR),



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which reduces or eliminates the use of big sag mills, resulting in a much more efficient process and saving approximately 40% energy in rock comminution."

Garib went on to mention how the role of mining suppliers has evolved in the last three years to become more of a partnership than before, given the scarcity of labor and tools as well as supply chain disruptions. "Miners understand that they cannot do everything themselves and thus need to partner with complementary companies," he said.

Suppliers are also forming business partnerships, such as Weir has with Andritz for tailings solutions, or M&A transactions to bolster certain areas of the business.

In 2021, the Weir Group acquired Canadian mining technology firm, Motion Metrics, through Weir's ESCO division, to serve as the company's global center of excellence for AI and Machine Vision technology. Shahram Tafazoli, chief of AI at Weir Motion Metrics and founder of Motion Metrics, discussed how, over the years, the company has developed technologies for fragmentation analysis to monitor particle size distribution (PSD): "Our value proposition is to optimize comminution through AI by putting AI enabled 2D and 3D 'eyes' into the process so that we can sense rock sizes in various stages of mining. High quality accurate data is sent to



Mining equipment is more valuable if it can respond to the needs of each client: they all have specific brands of components, as well as electric, structural and mechanical requirements, and each client has their own experience of how equipment responds to their maintenance and operational processes.



**- Andres Osorio,
General Manager,
Sistemas de Transporte de Materiales (STM)**



our secure cloud platform from where the information can be used to make recommendations for the mining process," explained Tafazoli, adding that this fragmentation monitoring solution allows for optimized production through selective mining, whilst reducing energy consumption and freshwater usage.

Tailor-made equipment

During interviews with many of the companies involved in the comminution and material handling space in Chile, one of the common trends has been the importance of tailoring solutions to the needs of the client and the mine environment rather than offering a standardized solution.

José Pablo Domínguez, general manager South America of ME Elecmetal, spoke of the company's work at INCO and QB2. "We proposed AMSA and Teck to perform an optimization process of the mill liners designed for the specific processes of each operation so new equipment could be installed ready to use," said Domínguez, stating that he expects both projects will achieve a smooth ramp-up of their mills and equipment because they will start with liners designed specifically for those environments.

Discussing ME Elecmetal's approach, Domínguez added: "When we take on a project, we are not only looking for excellence in the manufacturing of the spare part or the liner, but



also on the interaction of that component with the mill, the crusher, the equipment, the way they operate and the impact that will have on the tonnes per hour the mill or the crusher will yield, and/or in the mineral recovery."

On the topic of equipment customized to a particular project, Christian Cavagnaro, managing director of TAKRAF Chile, gave the example of his company's work at Codelco's Chuquicamata underground mine, noting that a project of this scale and complexity requires a lot of work to lower operating costs and reach the deposit.

Cavagnaro revealed that TAKRAF installed a high-power, high-capacity conveyor belt system, introducing gearless drive technology. "Gearless technology is not new, but it has only recently been introduced to conveyor belt systems," he said, elaborating: "We chose gearless technology because of its energy efficiency – CO2 emissions are reduced by ~66% as compared to diesel truck engines for the same copper production volume – and operational costs are reduced, as they require much less maintenance."

Considering the size of the conveyor, TAKRAF's belt technology partner also developed a new tension range belt to transport the material under such an extreme condition. "Since you cannot make a 6 km long belt, you have to do it in parts and splice the joints," explained Cavagnaro, continuing: "In the case of Chuquicamata this project achieves a number of world firsts, boasting the highest conveyor drive power of 58 MW and the strongest resistance belt in the world."

Sistemas de Transporte de Materiales (STM) is involved in designing and engineering customized conveyor belts, receiving the basic engineering from the client and then designing equipment for a specific application depending on the project and environment, according to Andrés Osorio, STM's general manager. He gave the example of STM's work with Collahuasi at more than 5,000 m above sea level: "Conveyor belts are high tonnage equipment, in general, which require maintenance and are subjected to adverse conditions."

Osorio also highlighted how conveyor belts reduce carbon footprint because they compete against trucks. "Just recently electric trucks and trucks that can use green hydrogen are appearing, but those technologies are in their infancy. Conveyor belts, on the other hand, are a mature solution that transports material efficiently because it works continually and with electric power," he said, adding that even though conveyors represent a higher initial investment depending on the project, conveyors not only decrease the carbon footprint but also the cost of tons transported due to savings in fuel.

The material handling space has various niches, from crushers and mills to conveyor belts and vibrating screens. Haver & Boecker's mining division (known as Haver & Boecker Niagara) produces technologies and solutions related to the classification and separation of solid materials – mainly vibrating screening machines, screening media (rubber and PU), and wire mesh. Illustrating the importance

of this machinery to mineral processing, Roberto Montiglio, general manager – Andean region, and global T.U manager for spares and services at Haver & Boecker Niagara, said: "An unplanned stop of a vibrating screen for five hours, for example, can create a bottleneck which costs (due to lost production) two or three times more than the equipment itself."

With that in mind, Montiglio discussed the company's two main product lines related to condition monitoring, industry 4.0, and IoT: "One is a traditional condition monitoring system where you install sensors on the machine to collect data, and the other which is currently very successful, especially in light of the pandemic situation, is a remote monitoring system which sends data to a cloud network every five minutes, seven days a week, 365 days a year. This data is then analyzed through a machine learning system to inform decision making and predict mechanical problems up to four weeks in advance." ■

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What would you say have been the main milestones achieved and challenges faced by Metso Outotec in 2021 and 2022 in South America?

In 2020 the merger of Metso and Outotec took place, a process that consolidated the company after two years as one of the main mining suppliers in the world, with solutions in the entire mineral processing line. We brought the best of both companies; one focused on crushing and the other with the best technologies in flotation. This has made Metso Outotec the reference point for the industry.

In the region we have seen growth of 15% to 20% business volume, despite challenges such as Covid, supply chain delays, and now the Ukrainian situation. In the case of mining, technology-based remote services permeated processing plants like never before due to the demands of social distancing, and the accumulated experience of our specialists and level of innovation that Metso Outotec has helped us navigate a difficult period and come out stronger as an organization.

Can you provide details of the in-pit crush and convey solutions (IPCC) order Metso Outotec won for Codelco's Radomiro Tomic mine?

At the Radomiro Tomic Óxidos project, Codelco seeks to give continuity to the open-pit mining operation through the exploitation of its sulfide and oxide reserves, operating its SX/EW leaching plant until 2030. To keep the mine operating in oxide extraction during this decade pending the completion of the sulfide project, it is necessary to access reserves that are below or near the current facilities. This is where Metso Outotec will play a crucial role, supplying Codelco with an EPS project that includes the installation of an 11,000 t/h semi-mobile crushing station with a state-of-the-art rotary primary crusher, a Superior MK III 60110, next to the pit mine while it is in production.

The solution also includes an Apron Feeder discharge, an intermediate transfer belt, electrical rooms, dust suppression systems, field assistance service and the extension of the overland sulfide belt by 530 meters. It is also important to highlight that the crushing station is part of Metso Outo-



Eduardo Nilo

President – South America
METSO OUTOTEC



Cochilco's list of investments for Chilean mining shows a portfolio of 51 projects with the potential to be executed between now and 2030 for US\$69 billion, but this will require collaboration between all actors in the industry, because the demands of communities and the environment are growing continuously.



tec's Planet Positive sustainable solutions, since its operation will mean a reduction of more than 30% in CO2 emissions at the project.

Can you tell us about Metso Outotec's data-analytics Performance Center in Santiago?

We have an integrated operations center in Santiago called the Performance Center. At the Center, data is collected in real time from the DCS or PLC systems, flowing to Metso Outotec Metrics, a platform that processes the information using AI algorithms. With this, we create dashboards for online monitoring. Our experts then analyze data in order to make recommendations for decision making and improving the productivity of plant equipment.

Can you explain how Metso Outotec can help clients achieve more sustainable operations?

For example, we have semi-mobile and mobile primary crushing plants in operation that reduce the distance to transport minerals by truck and allow minerals to be moved on conveyor belts with much greater energy efficiency.

Another relevant issue is the quality and durability of equipment and its ability to be repaired or updated.

In our portfolio we have recyclable, durable and environmentally efficient equipment that can be repaired to have optimal operating quality instead of being totally replaced; extending the life cycle of equipment reduces the manufacturing of new equipment, which translates into a lower environmental impact.

Can you outline Metso Outotec's vision for Chile's mining sector in the years ahead?

We are confident that Chile's rich mining tradition will continue in the decades ahead. On a global level, metals and minerals such as copper and lithium are becoming even more important due to their role in electromobility and the energy transition, and Chile has a key role to play in this transition.

Cochilco's list of investments for Chilean mining shows a portfolio of 51 projects with the potential to be executed between now and 2030 for US\$69 billion, but this will require collaboration between all actors in the industry, because the demands of communities and the environment are growing continuously. Metso Outotec is committed to supporting this with our team of more than 4,000 people in South America, and we plan to install more infrastructure in the region in the years to come. ■

Which of ME Elecmetal's solutions were in most demand in 2021 in South America, and can you elaborate on the work the company is doing at Teck's QB2 and Antofagasta's INCO project?

Although 2021 was a challenging year from the perspective of Covid and rising costs, it was a really successful year for ME Elecmetal in South America. We experienced important growth in almost every line, but especially in mill liners, grinding media, crushing parts and GET.

QB2 and INCO are two emblematic projects for the growth of mining in Chile, and ME Elecmetal has been in both from the beginning. We proposed AMSA and Teck to perform an optimization process of the mill liners designed for the specific processes of each operation so new equipment could be installed ready to use. That is why we expect, in both cases, that the clients will be able to achieve a smooth ramp-up of their mills and equipment, because they will start with liners designed specifically for those environments. This is unlike what is usually done, where standard mill liners are installed by the OEMS without taking into account for the distinctive features of the projects.

What do you think differentiates ME Elecmetal in the provision of solutions to the mining industry?

When we take on a project, we are not only looking for excellence in the manufacturing of the spare part or the liner, but also on the interaction of that component with the mill, the crusher, the equipment, the way they operate and the impact that will have on the tonnes per hour the mill or the crusher will yield, and/or in the mineral recovery. We have focused on learning about mineral processing and from that understanding, complementing our capacities with the equipment of manufacturing, maintenance and metallurgy of the mines to create the combination of solutions with the best performance.

How do ME Elecmetals solutions help reduce downtime and increase productivity?



José Pablo Domínguez

General Manager – South America
ME ELECMETAL



ME Elecmetal is working on several initiatives with mining companies to make changes to processes and products, such as upgrades to mill liners that allow mining operations to run more safely and efficiently.



The first thing we look for is preventing failure by delivering reliable and safe equipment. Secondly, we reduce downtime for maintenance; for that we have increased the size of the spare parts so that instead of changing 300 hundred pieces, for instance, only 150 need to be changed, thus reducing the time of installation. We also provide a service of maintenance monitoring, in which we follow up the micro and macro times to spot improvement opportunities. Furthermore, we continually update the design of our liners because downtime is one issue, but productivity is a whole other thing. For productivity we have found strategies to customize the lining profiles both for crushing and milling to achieve a better interaction between the milling balls and mill liners.

How is the company incorporating digitalization into its solutions?

Digitalization has brought up opportunities to capture a lot more information on what is happening both in crushing and milling, both in the mine with the shovels and the elements we provide, and from there we have been able to analyse the data to make improvements in products and services.

We incorporated our ME digital lab which has helped us implement solu-

tions such as extending the use of laser and the Digital Twin. We have also integrated an important number of sensors to send valuable information about what is happening inside the mill.

What are the main themes you see impacting Chile's mining sector?

We are seeing a mindset change regarding climate change. We have had many conversations with large mining operations and we are joining the sustainability strategy that mining is taking as an industry. We intend to make commitments to reduce our carbon footprint, incentivize circular economy processes, and help solve waste problems in mines. We have already made a lot of progress, for example, 96% of the raw materials we use for our mill liners are already based on recycled material, mostly recovered from the same mines.

Another key theme we see is the need to improve data analytics. Finally, we must continue to increase workplace safety for miners and remove them from harm's way. For that, ME Elecmetal is working on several initiatives with mining companies to make changes to processes and products, such as upgrades to mill liners that allow mining operations to run more safely and efficiently. ■

Can you introduce TAKRAF?

TAKRAF is focused on mining, bulk material handling and solid-liquid separation equipment and systems, and we operate in 15 countries. In the Americas, we have offices in Canada, US, Mexico, Brazil, Peru and Chile. Our headquarters are in Leipzig, Germany, which is where the company's technological center for management systems is located. We also have large technical center in India.

We are focused on tailoring technology and equipment to our customer's needs rather than developing products to introduce them to the market. Collaboration between the client and the OEM is an important aspect of TAKRAF's work, with the final objective of reducing investment costs and reducing operating costs. Automation is another focus area, and we are introducing artificial intelligence to ensure safer and more optimized operations. Automated systems allow for much faster and precise responses.

Can you highlight a case study example of TAKRAF's work with a mining company in Chile?

Codelco's Chuquicamata underground mine is one of the standout projects we have worked on. A project of this size and complexity requires a lot of work to lower operating costs and reach the deposit. We installed a high-power, high-capacity conveyor belt system, introducing gearless drive technology. We installed two inclined belts covering a distance of 7 km with a capacity of 20MW) each consisting of four 5 MW gearless motors, that overcome the roughly 1 km vertical elevation to the surface. We also installed a 6 km overland conveyor with a capacity of 15 MW. We chose gearless technology because of its energy efficiency - CO2 emissions are reduced by ~66% as compared to diesel truck engines for the same copper production volume - and low operational costs, as they require much less maintenance. To manage all this, our belt technology partner also developed a new, ST10000 tension range belt to transport the material under such an extreme conveying solution. Since you cannot make a 6 km long belt, you have to do it in parts and splice the joints. In the case



Christian Cavagnaro

Managing Director
TAKRAF CHILE



Collaboration between the client and the OEM is an important aspect of TAKRAF's work, with the final objective of reducing investment costs and reducing operating costs.



of Chuquicamata, this project achieves a number of world firsts boasting the highest conveyor drive power of 58 MW and the strongest resistance belt in the world.

Can you explain how bulk material handling or processing facilities can improve the environmental aspects of a mining operation?

All aspects of sustainability are important, but I am going to start with two that are simple where material handling systems play a key role - noise reduction and dust contamination. Conveyors are equipment that removes dust contamination, in contrast to trucks, for example.

The other aspect is that conveyor belts use electrical energy, which can be obtained from renewable sources, whereas most traditional forms of transportation use fuels, which generate carbon emissions.

How do TAKRAF's stockpiling and loading/unloading of saleable material services help companies overcome supply chain and logistics complications?

Within TAKRAF's product portfolio we have systems and equipment that allow stockpiles to be stored in large quantities. For example, in Brazil we transport a type of ground sugar cane used as

fuel for energy generation plants, not just ore. Also, within TAKRAF, we have ship-loaders that specialize in large tonnage and high-tech vessel loading and unloading. As example of this, we were chosen to supply key material handling equipment (wagon unloading station and ship loader) for a bulk terminal expansion project in Canada.

What is your outlook for the mining equipment opportunities in Chile in the years ahead?

With the high level of uncertainty that exists, it is difficult to have a concrete answer. However, one thing that is certain is that as humanity continues to grow, water, food, metals and minerals have to be produced. Production of minerals will also increase due to electromobility, and Chile will play a significant role in this transition as a major global producer of copper and lithium. Our Group also sees a lot of opportunity to implement high-tech solutions that will enable this production, particularly in underground settings, which require innovation to become economic, safe and efficient. Lastly, limiting our impact on the environment by adopting more sustainable technologies such as IPCC, DST and the re-use of process water through dewatering and our DELKOR processing equipment bodes well for the future. ■

Can you introduce Haver & Boecker and describe the company's areas of focus?

Haver & Boecker's mining division (known as Haver & Boecker NIAGARA) produces technologies and solutions related to the classification and separation of solid materials - mainly vibrating screening machines, screening media (rubber and PU), and wire mesh. We have two main product lines related to condition monitoring, industry 4.0, and IoT. One is a traditional condition monitoring system where you install sensors on the machine to collect data, and the other which is currently very successful, especially in light of the pandemic situation, is a remote monitoring system which sends data to a cloud network every five minutes, seven days a week, 365 days a year. This data is then analyzed through a machine learning system to inform decision making and predict mechanical problems up to four weeks in advance. Our experience and core business is these monitoring systems specifically for vibrating screening machines. An unplanned stop of a vibrating screen for five hours, for example, can create a bottleneck which costs (lost of production) two or three times more than the equipment itself.

What are the main benefits of Haver & Boecker Niagara's vibrating screens?

Haver & Boecker Niagara has two centers of excellence in the Americas - one in Brazil, which is mainly focused on large linear motion vibrating machines from our German side of the business; and one in Canada, which is focused on the original W.S Tyler machines that are more medium to small sized. Haver & Boecker Niagara manufactures T-class and F-class vibrating screens which rotate in a circular motion rather than linear, with the difference being that the T-class has two bearings and the F-class four in the main shaft. The benefits of having four bearings is that you have a fixed amplitude of movement, which is an ideal solution for challenging screening applications requiring consistent performance, load independence and minimal vibration transmission into the structure.



Roberto Montiglio

General Manager - Andean Region,
and Global T.U Manager for Spares and Services
HAVER & BOECKER NIAGARA



We work with everyone along the mining lifecycle - from directly with mining companies to contractors and EPCM firms.

**What types of companies do you supply products to and what services does the company offer?**

We work with everyone along the mining lifecycle - from directly with mining companies to contractors and EPCM firms. We are focused on keeping the total cost of ownership as low as possible for our customers.

Our sales and services relate to new machines, replacement machines, condition monitoring technologies, and services and spare parts. We provide our customers all components and spare parts to keep their machines in top condition. We also have a refurbishment division where we completely disassemble old machines, replace parts that need to be replaced, repair parts that can be repaired, and reassemble the machine. We guarantee that our refurbished machines are as good as new, and customers then basically have a new machine while saving near 40% on costs.

Which challenges have you noticed in the manufacturing of material handling machines recently?

The high price cycle combined with inflation and supply chain delays is impacting the industry as cost for materials such as steel needed to manufacture material handling equipment has

also increased, leading to higher cost of equipment for our customers. From November 2021 to April 2022, we saw international steel prices increase by approximately 50% in some markets, including North America, which is a key hub for us.

What potential do you see for Haver & Boecker Niagara's growth in the mining sector in the years ahead?

High commodity prices are giving a new lease of life to the mining industry, and we expect that projects that were suspended or are on standby will soon be progressing again. In the Chilean market, we have seen the need for getting new projects online, and most Peruvian projects are keeping on track. Over the past three years, Haver & Boecker has seen great success with new machines in the Peruvian market, but this has not been same in the Chilean market, maybe due to the pandemic, the international situation, and the current geopolitical situation in the country creating uncertainty and putting the mining industry on standby. We however expect a relaunch of the Chilean market in the near future, especially in light of high copper prices and expected increased demand which will require increased production capacity. ■

Pipes & Valves

Sustainability is driving piping and valve innovation

The reduction of diesel emissions was one of the key areas of focus at the 2022 World Copper Conference in Santiago, with Rag Udd, BHP's president minerals Americas, giving an open invitation to companies that could assist in this area. While electric or hydrogen-powered vehicles are one option, the industry already has alternatives for certain processes, such as pumps.

Ricardo Garib, president of Weir Minerals, discussed some of the environmental benefits of using pumps: "With our GEHO ZPM Piston Diaphragm pumps, instead of having, as an example, 100 trucks a day, transporting concentrate over 300 km or so from the mine to a port, our solution uses several pumps in series

which can transport slurry through a pipeline to the port, eliminating the need for truck transport."

Pedro Urzua, general manager – Chile at Fastpack S.A., commented that as providers of piping and valves for fluid handling and control systems, Fastpack's priority is to prevent spills or leakage events along customers' pipelines. "There is a percentage of water that is lost in the clients' processes, sometimes up to 30%, due to improper use or equipment," he explained, adding that to minimize water loss, Fastpack trains its customers' operators to help them to get the best performance of the equipment and materials, resulting in greater ROI and more sustainable operations.

Innovation in the valve segment of the mining industry, through smart flow control solutions, is also enhancing the sustainability of mining operations. Gonzalo Silva, regional manager of Valmet, which completed its merger with Neles on April 1st, 2022, explained how the company's software helps avoid unnecessary stoppages, reduces waste from the process, reduces the replacement of equipment, and avoiding contamination due to excessive consumption of any product.

Silva gave the following example: "To this end, we have solutions called Zero Leakage. These solutions guarantee that everything being controlled by our valves is going to stay within the process and not go out into the atmosphere." ■



Ricardo Garib

President
WEIR MINERALS

What are the most noticeable trends in Chile's mining suppliers sector in 2022?

Firstly, the role of mining suppliers has become more of a partnership than before, given the scarcity of labor and tools as well as supply chain disruptions. Secondly, accelerated by the pandemic, most large corporations, including Weir, adopted digital tools to make services and supplies more effective. This also forms part of the sustainability agenda, and given the new government in Chile, there is an even stronger focus on sustainability and ESG. Mining companies are using less water and energy, and although they are ahead of the curve, community requests related to the environment are stronger than before.

Can you provide examples of how Weir Minerals helps mining companies optimize their operations and become more sustainable?

In terms of comminution, Weir has developed and improved a technology called High Pressure Grinding Rolls (HPGR), which reduces or eliminates the use of big sag mills, resulting in a much more efficient process and saving ap-

proximately 40% energy in rock comminution. In terms of pumps, to make our slurry pumps more efficient, our team does audits to optimize the use of this equipment in plants to achieve greater productivity and energy savings. Finally, with our GEHO ZPM Piston Diaphragm pumps, instead of having, as an example, 100 trucks a day transporting concentrate from the mine to a port, our solution uses several pumps in series which can transport slurry through a pipeline to the port, eliminating the need for truck transport.

Can you elaborate how Weir Minerals' Synertrex platform works and what are its benefits?

Mines are a dynamic body that keep changing and therefore automated adjustment is critical for optimal efficiency. The Weir Group recently acquired Motion Metrics, which has a tremendous scanning tool that can size and identify what you are feeding onto a track and what is going into the crushing plant. Through AI, particle sizes or sharpness are identified and machines can then self-adjust accordingly. ■



Pedro Urzua

General Manager – Chile
FASTPACK S.A.

What are the standout mining projects that Fastpack has been involved in?

For the last years, we have been developing our solutions in BHP's SGO project, Teck Resources' Quebrada Blanca 2 project, AMSA's INCO, and the Coldelco's Rajo Inca project, among many others.

Our other business units that we are looking to transition to are the Industrial Valves and FPS (Fire Protection Solutions) units, which was developed as an innovative add-on for the industry in terms of safety, leveraging our already proven excellence in fluids handling and management.

What is Fastpack's approach to improving the sustainability of its operations?

We have already taken actions not only in terms of sustainability for our customers projects, but internally also, starting with recycling initiatives, carbon footprint reduction programs, changing our diesel-based machinery to gas powered by green energy sources, and in the short term to replace our electricity grid to a 100% green one.

Regarding the sustainability of Fastpack's products, one of our differentiating factors is the start to finish, quality assurance system, ensuring a fault-free product for customers, but more importantly, creating more environmentally safe and sustainable operations.

We not only think in terms of "things", teams and people are a main concept in our "moto", hence, we are also working in equality, and the last three years we have gone from 15% of our workforce being female to around 20%. The focus is to reach 30% before 2025, including, of course, not only operational positions, but management, senior management, and leadership also.

Can you explain how Fastpack looks to prevent corrosive and abrasive phenomena?

There is a technical approach to answer your question. When an abrasion or corrosion project is presented to us, we first work in joint with our allies or partner, who provide us their previous experience in similar scenarios and, according to this knowledge, we deliver a solution proposal that best adjust to the customers' requirements. ■



Gonzalo Silva

Regional Manager
VALMET

Valmet Oyj and Neles Corporation announced the plan to merger in July 2021. What were the reasons behind the merger?

Neles and Valmet share a common heritage as well as a culture of performance orientation. Formerly these companies were linked under the Metso Group; Valmet was reborn through the demerger of the pulp, paper and power businesses from Metso Group in 2013 and Neles through a demerger of the flow control business in 2020. The combination of Valmet and Neles on April 1, 2022, creates a leading company with a unique, competitive and balanced total offering for process industries globally, including process technologies, services, automation solutions and flow control. The combined company will be called Valmet Oyj and Neles' operations continue as the Flow Control business line within Valmet. Together, we will have a globally balanced expert organization of approximately 17,000 professionals.

Can you provide an overview of the range of flow control solutions and services the company offers?

Our flow control offer includes globe valves, butterfly valves, ball valves, segment valves, eccentric plug valves, and nowadays also pinch valves, and knife-gate valves after the acquisition of Flowrox™ valves and pumps business. Our valve service portfolio covers all the activities related to corrective maintenance, analysis and diagnosis of equipment operation, maintenance recommendations, field support for maintenance and supervision, replacement recommendations and analysis of installed base. We have also developed a software platform that analyzes the control loops of a distributed control system to give recommendations on how to better tune the loops and achieve process optimization.

In 2006 we opened our first service center in Concepción. Over time, we noticed that we needed to provide more dedicated and faster support to mining clients who were in the north. Because of this, we started the construction of a service center in Antofagasta in 2021. ■

Innovation & Technology

Changing mindsets and using actionable data

Innovation has evolved from a benefit to a necessity, not only in order to process lower-grade deposits more efficiently or reach deposits that were previously inaccessible, but also in the fight against climate change.

“Remote operations is a big trend which, even though it is something we have been pushing forward for a long time, has really accelerated since the start of the pandemic,” stated Jorge Abraham, country division manager – process industries, and mining lead at ABB Chile.

Abraham commented that ABB has been developing remote operation solutions for decades, but the industrial segment had dragged its feet as companies did not believe it was necessary or possible, particularly in a mining setting. “Fortunately, this way of thinking has changed completely. Parallel with this came the digitalization of a series of processes that used to be done manually and now had to be digitized to remove workers from the site.”

One of the pioneers of remotely operated mining technology is Canadian company HARD-LINE. Brian Larocque, HARD-LINE’s general manager in Chile, explained the transition from line of site control (an operator standing in front of the equipment watching it work from a safe distance) to teleoperation. He gave the example of autonomous blasting at a sublevel stoping operation as an illustration of how productivity can be increased: “Autonomous operations allow for much less down time as usually after a blast you will not be able to send anyone into the mine for two hours, but now the autonomous equipment can be operating.”

For the open-pit market, Larocque discussed HARD-LINE’s partnership with Hexagon to develop autonomous situations such as collision avoidance, GPS and drilling patterns: “We marry Hexagon’s systems with HARD-LINE’s systems and based on the combined technologies the equipment can move from teleoperation to semi-autonomous operation to fully autonomous operation.”

Rodrigo Couto, president Latin America for Hexagon’s Mining division, spoke of Hexagon’s partnership with Liebherr to deliver automation solutions: “The most impactful aspect of this is Hexagon’s autonomous mission management system, which orchestrates fleet and unmanned mine traffic movements throughout the mine for optimized haulage”.

Discussing the evolution of automation in the mining industry, Óscar San Román, general manager – Chile at Yokogawa, suggested that the aim is a much bigger goal – autonomy.

Elaborating on this statement, he observed that some decades ago, the focus was on collecting data from a plant. Then came the challenges of understanding and communicating this data, which has been solved. More recently, what to do with that data has been driving innovation, through machine learning and others advance control systems.

“The pandemic has accelerated remote control systems and the implementation of digital infrastructure: you can now have someone in Santiago or London not only supervising but controlling a plant in northern Chile or South Africa, thanks to technologies such as 5G communications,” said San Román, noting that the challenge now is the integration of these aids for the long-term. He concluded: “Automation is today the only way to advance in an efficient, profitable and sustainable mining industry.”

Brad Donnelly, managing director – mining at Dingo, weighed in on the subject, reflecting on what the Australian technology company had learned in over 30 years in the mining market: “Over the years, we have learned that collecting volumes of data without a clear goal adds complexity and delivers little value. It is critical to apply context to that data to transform it into meaningful action that can make a material impact on a mine’s performance and productivity.”

Dingo’s flagship product, Trakka, a cloud-based predictive maintenance software platform, manages, analyzes and acts on all of the asset health data of its mining clients, helping to leverage existing condition data to minimize downtime and optimize asset life.

MC System Chile, representatives of Leica Geosystems, is a Chilean mining tech company founded in 2011. Its Machine Controls (MC) are topographic systems onboard machines (such as excavators) that help the operator work to the desired quota, eliminating over-excavating, markings on the floor, and the need for people controlling the floor or staking pegs. The company has worked at operations including Los Pelambres, Los Bronces and Quebrada Blanca, and Christophe Boinelle, director of MC System Chile, suggested that this technology should be provided by a small com-



The greatest challenges related to digitization in mining surround the interoperation of the components, making sure all operational and IT technology is functioning properly and that the computing environments in development on the cloud are properly protected by good cyber security.

– Francisco Waltersdorfer Rivera, General Manager, Adexus Chile



pany due to the flexibility required. “When you start working with these systems the machine will work much faster, but if something goes wrong with the system, such as something getting unconfigured or a wire getting cut, the operator goes blind because there are no markings on the floor like before. We are very fast at fixing it,” explained Boinelle, noting that all the protocols larger companies have to comply with make them less efficient.

Changing mindsets

As one of the world’s leading mining jurisdictions, Chile is advanced when it comes to the adoption of innovation at mine sites. “The mining boom in the 1990s triggered the growth of mining expertise in Chile and the industry has grown alongside emerging technologies,” explained Eduardo Coloma, CEO of Maptek.

However, Coloma acknowledged that the mining industry on a global level is struggling to attract new, young talent. Fostering a younger generation of mining professionals is not only important to keep up with demand, but will also help from the standpoint of technology adoption.

“The main barrier to adoption is culture, not only in the mining market but across industries, and thus change management is extremely important,” commented Mauricio Gregorio, Siemens’ digitalization manager for Chile and Peru, adding that the mining market has come to understand that digitization will be the main driver of increasing main KPIs such as productivity, safety and reliability.

Hexagon’s Rodrigo Couto remarked that Chilean mining is advanced with respect to the adoption of many technologies, but catching up when it comes to collision avoidance systems and fatigue monitoring. Many of Chile’s largest mines have had unionized workforces for decades, which have contributed to better working conditions and fairer pay. However, new technologies can be seen as a threat to a traditional way of doing business. “We have been talking with the unions in Chile to explain that collision avoidance systems and fatigue monitoring technologies are not meant



The mining market has come to understand that digitization will be the main driver of increasing their main KPIs such as productivity, safety and reliability.

– Mauricio Gregorio, Digitalization Manager – Chile and Peru, Siemens



to expose drivers but rather to protect them instead so that they can return home safely,” said Couto.

Once the challenge of changing mindsets to introduce technology has been overcome, companies need to be prepared to run and maintain systems that are frequently cloud based. This also comes with challenges, such as ensuring cybersecurity. Francisco Waltersdorfer Rivera, general manager of Adexus Chile, described the current operational environment as “a perfect storm” when it comes to cybersecurity breaches, consisting of a fragmented processing system with multiple suppliers, many networks with perimeters that have not been properly defined, new technologies such as AI, and a scarcity of resources to manage these systems. He warned: “Many companies will not recognize the problem until they have had a major incident.”

Waltersdorfer explained how Adexus helps mining clients tackle such challenges: “Adexus has an advanced cyber security team that provides solutions such as firewalls, traffic analysis and secure gateways, as well as supporting final users make sure that risks are avoided and identified as soon as they occur.”

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HEXAGON

The Power of One partner for your mining solutions

How has Hexagon's Mining division evolved in recent years and what is the company's focus today?

Hexagon's Mining division is part of Hexagon AB, a Swedish multinational technology organization that was founded more than 20 years ago and has grown to have a global presence in 50 countries, generating revenue of US\$5.1 billion. Over the past decade, Hexagon has been scaling its mining technology portfolio through a combination of organic growth, M&A and partnerships. These include the January 2022 acquisition of Minnovare, a leading provider of drilling technology that improves the speed, cost and accuracy of underground drilling; and partnerships with OEMs such as Liebherr to advance automation, or fellow technology companies such as HARD-LINE to expand teleoperation capabilities.

Today, Hexagon has a go-to-market strategy called 'Power of One', which is a holistic solution connecting all processes of a mine from the pit to the plant, leveraging data from connected workflows to maximize the value of productivity, safety and sustainability at an operation. Our technologies cover the areas of mine measurement, 3D modelling and design, and solve both surface and underground challenges, with the main goal of developing smart mines through a feedback loop between the real and digital worlds.

Hexagon's mining solutions include fleet management, asset health, machine guidance, and analysis solutions to optimize operations; a safety portfolio including collision avoidance, operator alertness, and vehicle intervention; as well as drill and blast, enterprise, and monitoring portfolios. Through technology, we aim to simplify operations for our clients and make their lives easier.

What would you say are the main barriers to break down the silos that exist in the mining sector?

In 2021, Hexagon implemented 61 projects in Latin America. The main challenge we encountered in most of these projects was to break the paradigm of keeping data inside each silo. Clients care a lot about data and spend a lot of time collecting it, but many do not know how to transform data into actionable



Rodrigo Couto

President – Latin America
HEXAGON'S MINING DIVISION



One of our focuses is educating the market to convince users that sharing data in a meaningful way is going to be beneficial to their operations.



information. Hexagon offers clients an integrated ecosystem which guarantees a single source of data, which is automatically transformed into actionable information, connecting different workflows to enhance efficiency and productivity. One of our focuses is educating the market to convince users that sharing data in a meaningful way is going to be beneficial to their operations.

Can you elaborate on Hexagon's partnerships with HARD-LINE and Liebherr?

We partnered with HARD-LINE, a leading supplier of automation, teleoperation and remote-control technology for the mining industry, to combine our technologies so that mine workers can be removed from dangerous environments. We have already implemented a remote center at Vale in Brazil so they can remotely manage tailings dams from an office. These remote operations run 24/7 to evaluate any kind of displacement or potential risk of failures of the dams in real time.

Hexagon has partnered with Liebherr to deliver next-generation automation solutions. The most impactful aspect of this is Hexagon's autonomous mission management system, which orchestrates fleet and unmanned mine traffic movements throughout the mine for optimized haulage.

Which areas of mining technology adoption have room for growth in Chile?

Chilean mining is advanced with respect to the adoption of many technologies, and catching up when it comes to collision avoidance systems and fatigue. We have been talking with the unions in Chile to explain that these technologies are not meant to expose drivers, but rather to protect them instead so that they can return home safely.

What are the main factors you believe will drive the growth of mining technology in the coming years?

Over the past two years, the highest demand in the mining technology space has been for collision avoidance systems, fatigue monitoring systems, vehicle intervention systems (VIS), teleoperations and autonomy. We are currently very much focused on everything related to safety, as well as data science, including AI and big data.

Investors are looking to put their money into safe, profitable and responsible operations. Because ore grades are getting lower and ESG standards are becoming stricter, mining companies have to invest in disruptive and transformational technologies to optimize their operations so they can continue to attract investment. ■



Carlos Leigh

Regional CEO – Latin America
DSI UNDERGROUND

How has the integration period progressed since DSI Underground was acquired by Sandvik in 2021?

Integration is progressing as planned, and we are improving day by day and successfully avoiding any disruption in our processes, while maintaining our quality and service as always, and gradually improving these together with Sandvik Mining and Rock Solutions.

We have discovered a great partner and we both share the same purpose, concentrating our efforts in order to offer the best solutions in ground support, always with our customers in mind.

What are some of the standout Chilean projects that DSI has been working on, and which of your solutions have been in high demand in the country?

In one way or another, part of our business in Chile is usually related directly or indirectly with Codelco. We continue serving an important part of the market as contractors at the mines. Codelco PMCH (Proyecto Mina Chuquicamata Subterránea) is one of our most important project nowadays, where we are working to assure the best underground support and ventilation products, while using the best and most relevant technology available. We manage this work very closely with our client, and we consider our customer the most important part of the chain, helping us with their knowledge and trust to develop new products so that we can offer the right ones for their specific needs.

Can you provide a case study example that demonstrates the different ways in which DSI's technology has added value to a mining operation in Chile?

We have some good examples over the last 15 years, but I believe that one of the latest is a new steel beam arch that, with some special adaptations in the design and functional structure, allow it to improve by more than 25% the resis-

tance of a system including cement, considerably reducing the risk of rock fall.

Which of DSI's ventilation solutions have been gaining traction in recent years?

It has being an incredible journey since we started our Joint Venture in 2020 with ABC Technology Group. All their experience, technology and innovation is today a reality in Chile and can be found in all the different regions. One of the most important innovations is the HardLine, a new duct made with a high resistance semirigid plastic that replaces in some cases a steel ducting. This is a long time duration system, easy to install with much better ventilation capabilities than the steel. This is a recent innovation of our partners in Canada and very soon we hope to start a local production in Chile, reducing considerably the extra costs related with freight and improving delivery timing, which is a critical issue for our customers.

What potential do you see for growth in Chile's mining sector as many operations transition underground, and how can DSI help clients through this process?

More than potential growth, today growth is a reality, and this is where DSI Underground and Sandvik Electrical and Automated equipments are leading the transformation currently underway in the mining sector globally and in Chile.

We continue offering the best technical support, service and quality in the market, focusing all our efforts on our customers's needs. ■

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OUR PORTFOLIO INCLUDES:

- Rock bolts and anchor systems
- Self drilling systems
- Passive support products including profiles, girders, mesh and rock bolt straps
- Drainage drilling systems
- Injection resin/chemical systems & cartridges
- Pre-support systems including pipe umbrellas, spiles and fore-poling boards
- Selective active support solutions

www.dsiunderground.cl DSI Underground LATAM



Jorge Abraham

Country Division Manager –
Process Industries, and Mining Lead
ABB CHILE

Can you provide examples of ABB's different work with mining companies?

We have worked a lot on remote operations from Santiago, helping to digitize processes in areas like data acquisition. We have also worked in underground mining operations on ventilation, which is the single largest cost and a huge driver of energy consumption in these operations. This includes software that illustrates how the mineshaft goes downward, and with sensors that can measure air flow to optimize the process and save 30% to 40% of your energy usage for ventilation. If you combine this with other technology like high efficiency conveyor belts, you can really make a difference in from an efficiency and emissions standpoint.

How would you evaluate Chile's position as an epicenter for mining innovation in Latin America?

Chile has been at the forefront of technological advancements in Latin America when it comes to mining operations. Control systems in Chile have been operating plants with automatization sys-

tems, which has started to be mirrored by neighboring countries. At the moment, I would say that Chile is a step ahead of other countries in Latin America when it comes to the implementation of mining technologies, but other countries are accelerating these processes as they become more commonplace throughout the entire industry.

Can you speak to the importance of facilitating collaboration along the supply chain to realize sustainability goals?

This has long been a focus of ABB. We have collaborated with other companies. We have also been working with a truck supplier in order to develop the electrification of a mining truck. ABB has business management systems that work from the arrival of trucks to a plant with raw materials, to the delivery of the finished product to ports and clients. All of the inputs that a client needs, such as energy and water consumption, are displayed in a centralized fashion, which allows decision makers to work more effectively and in real time. ■



Shahram Tafazoli

Chief of AI
WEIR MOTION METRICS

Can you give details regarding Weir ESCO's acquisition of Motion Metrics, including how the two companies have integrated?

In 2018, Weir, a large mining engineering firm with over 150 years' experience headquartered in Glasgow, Scotland, purchased the 100-year-old company, ESCO, a world leading manufacturer of large mining and infrastructure equipment. ESCO had been interested in acquiring Motion Metrics for a while before the merger with Weir. In acquiring Motion Metrics, there was a recognition of the importance of our focus on using machine vision and AI in disruptive and novel solutions to tough challenges in the industry. The deal was closed in December 2021, with Motion Metrics now part of Weir's ESCO division.

Motion Metrics' seven regional offices have been integrated into ESCO and the new Weir Motion Metrics company now has access to over 65 countries with many offices around the world. Our previous Vancouver headquarters is now Weir's global Centre for Excellence in AI and Machine Vision Technol-

ogy. Since establishment, we've had the ambition of using a combination of rugged 3D vision, AI, and machine learning to improve safety, efficiency, and sustainability in the mining sector. Being integrated into a larger public company provides access to resources, capital to grow, and a broad expertise in mining to better work towards our vision and goals.

How does Weir Motion Metrics utilize artificial intelligence (AI) and computer vision to solve issues surrounding sustainability in mining?

We have developed technologies for fragmentation analysis to monitor particle size distribution (PSD). Our value proposition is to optimize comminution by installing AI enabled, 2D and 3D 'eyes' into the process so that we can sense rock sizes in various stages of mining.

This is a paradigm shift which allows for high quality decision making during the mining or comminution process - such as improving blasting or crushing and identifying over-sized material. ■



BD



SG

Brad Donnelly & Silvia Gonzalez

BD: Managing Director – Mining &
SG: Regional Partner – South America
DINGO

Can you introduce Dingo and give us a brief history of the company?

Dingo has been operating for 30 years and we have a great history of improving asset health at over 260 operations worldwide. The company's mission is to provide actionable knowledge for machines that matter and our software and people have an intimate knowledge of large, mechanical assets. With digitalization, sensors, analytics, and advancement in technology, we have seen an evolution of maintenance strategies in the mining sector, from run to failure, all the way to condition based and predictive maintenance, which is where we play.

We have several long-term partnerships and in 2020, the company signed a global agreement with Newmont, which saw the leading gold miner expand the use of our software Trakka to manage workflow generated from its Operations Support Hubs at their operations on four continents. Our corporate offices are in Brisbane, we have a regional office in Denver, and a network with partners such as Petrobusiness in Latin America.

How does the company's predictive maintenance technology work?

Trakka, Dingo's flagship product, is a cloud based predictive maintenance software platform. It has the ability to ingest a customer's asset condition data into a single platform and provides mining operations with the right tools, insights and decision support to run a best-in-class asset health program, which efficiently manages, analyzes and acts on all asset condition data from one tool. We also have a mobile Asset Health Manager app, which is an end-to-end solution for field inspection, data capture and analysis.

What growth opportunities do you see in Chile's mining sector?

Chile holds massive opportunity as the demand for transition energy metals like copper and lithium increases. For Dingo, there are enormous opportunities to support this growth and we believe predictive maintenance solutions like Trakka are going to experience high demand as they bring value to miners through driving increased availability and production. ■



Brian Larocque

General Manager – Chile
HARD-LINE

How are remote controls and autonomy leading to safer operations with less down time?

In recent years, there has been added interest in removing people from work-sites, for safety reasons, with the uprising in Chile in 2019 and now the pandemic. Remote control technology was developed due to new mining methods. For example, sublevel stoping, where with a huge ore body, you blast it but you can only go in so far safely as you have no protection over the operator. This is where the operator will use remote line of site technology to remove the material. When you are taking it to the next level of semi-autonomy and full autonomy you don't need the operator in the mine as he can operate equipment from surface and from a distance. Autonomous operations allow for much less down time as usually, after a blast you will not be able to send anyone into the mine for two hours, but now the autonomous equipment can be operating.

HARD-LINE offers solutions such as eliminating the possibility of anyone

accidentally driving into a stope area, using our new Brow Alert System. While mucking material with someone physically driving the scoop, if the scoop passes a certain zone it will actually shut off and will not allow the driver to go in. The operator then has to move to remote control, or if he has gone too far, he will have to get his supervisor to start the equipment back up. With the semi-autonomous systems, when it is in operation we actually have the entire zone blocked off so that nobody can physically go into the area while the equipment is operating.

Can you explain how HARD-LINE's technology is adopted by mine workers?

The learning curve for the younger generation is much quicker as they grew up with and are used to digital technologies. These days operators are far more willing to accept remote technologies as many have seen first-hand that they create a better working environment, and it is a trend we expect to continue growing. ■

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Equipment Components

Brownfield expansions have been the greatest area of investment in the Chilean mining sector, with a number of greenfield projects on hold until uncertainty surrounding constitutional change and royalty regulations have cleared. This offers opportunities for the companies that supply components to material handling manufacturers and OEMs.

"We have seen great demand for bearings in the comminution stage, where conveyor belts are a critical part of mining operations and they require reliable solutions that can endure all types of contamination along the way, such as water and dust," said Carlos Lahura, managing director – Andean region at SKF Group.

SKF has invested in new technologies such as the SKF Cooper solution for conveyor pulleys, which utilizes triple barrier technology to reduce the contamination, while at the same time reducing the time needed for maintenance by including a split bearing. Lahura added: "This innovation for this critical application results in significant reductions in downtime and immense savings in plant maintenance."

Alvaro Palazuelos Gonzales, general manager – South America for Australian equipment supplier Austin, revealed that the company's most popular solution in the Chilean market has been Austin's dump truck bodies, having sold more than 600 units since 2019. He went on to discuss the benefits of Austin's focus on customization, giving the example of the company's work at Collahuasi: "The TBO (total benefit of ownership) of the dump truck bodies used to be 15,000 hours at Collahuasi, but with Austin's customization it increased to between 22,500 and 30,000 hours."

Austin's La Negra base in Antofagasta became the company's Latin American headquarters in November 2020 after the decision to close operations in Colombia and Peru and to supply these markets from Chile in the south, or from Wyoming in the north. Palazuelos said the decision behind this restructuring is to focus on the manufacturing of dump truck bodies and buckets – "something that we have a lot of expertise in globally, but have room to grow in South America."

Another Australian company experiencing growth in South America is Hofmann Engineering, which has a range of mobile mining equipment such as draglines, electric rock shovels, excavators, blast hole drills and wheel loaders, gearbox solutions, and a range of fixed plant equipment such as HPGRs (High Pressure Grinding Rolls). Simão Antunes, Hofmann's general manager – South America, said that the company has seen great demand for its HPGR components in the region, becoming the first non-OEM company to supply HPGR rollers in Chile and Peru. He gave the example of Cerro Verde in Peru, where Hofmann has the best performing tires at the operation. "This is a result of ongoing work in improving the technical features of our HPGR rollers together with listening to customer feedback to make slight changes on our products to accommodate for better performance. We have been able to reduce manufacturing costs leading to decreased operational costs at Cerro Verde."

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Alvaro Palazuelos Gonzales & Max Flores

APG: General Manager – South America, & MF: Regional Business Development & Special Projects Manager Latam AUSTIN

Can you tell us about Austin's presence and areas of focus in Chile, including the capabilities of the company's La Negra base?

APG: Austin's La Negra base in Antofagasta has been the headquarters of our Latin American operations since November 2020. The decision was to close operations in Colombia and Peru to supply these markets from Chile in the south or from Wyoming in the north. The focus is towards the manufacturing of dump truck bodies and buckets.

Which of Austin's solutions are most popular in the Chilean mining market?

APG: The most popular solution has definitely been Austin's dump truck bodies. In recent years we have also been entering in the repair market very strongly, particularly for buckets.

What are some of the latest innovations Austin is developing?

MF: Our Westech Body, which has been in the market for over 50 years,

has had an evolution, and we now have the Premier Westech truck body, which optimizes all the knowledge we have acquired through our experience and allows us to compete with heavy duty truck bodies, but in the ultra-light sector. In other words, we offer a lightweight body keeping the same structure as a heavy duty one. Our premier body carries more, weighs less, but also lasts longer.

Another innovation we want to introduce to South America is the Flow Control Body, which was developed in Wyoming and helps achieve greener operations. When the load is dumped, this body has angles that allows the user to control the flow of the material and kicks up less dust, which helps keep the mine clear.

Our third innovation comes from the design and fabrication of our buckets for electric shovels, where we incorporate lighter designs, which allow us to care for the RSL (rocker shovel loader) to increase the useful lifespan of its components. ■



Simao Antunes

General Manager – South America HOFMANN ENGINEERING

Can you give an overview of the range of mobile mining and fixed plant equipment Hofmann Engineering designs and manufactures?

The most important product areas we have are Mobile Mining Equipment, including Electric Rope Shovels, Haul Trucks, Hydraulic Excavators, Rotary Blast Hole Drills, Wheel Loaders - and for fixed plant equipment HPGRs, Mill Gearing, Crushers, Stackers, Reclaimers and Ship-loaders.

What are some of the standout projects and clients Hofmann Engineering has worked with in South America?

In South America, we have seen great demand for our HPGR components and Hofmann Engineering has been the first after-market non OEM Company to supply replacement HPGRs for change outs for Chilean, Mexican and Peruvian mining operations.

In SMCV in Peru we have the best performing tyres in operation. In Chile with Sierra Gorda our HPGR rollers performed very well. We continue to assist the customers with ongoing, multiple requirements.

On the MME side our transmissions have an excellent reputation with long service performance and a very fast repair service catering for customers that want a quick turnaround and we assist on a regular basis big customers such as Escondida, Collahuasi, Los Bronces, AMSA, SPCC and Antamina, as a few examples.

Another success story is the trackpads for 7495 Shovels where we have the record performance in a copper mine exceeding 35,000 hours of operation, which has brought many more business opportunities with new customers and markets recently.

What is Hofmann Engineering's strategy for growth in South America for the coming years?

Our strategy moving forward is to double the size of both of our workshops in Chile and Peru, as well as installing selected machinery at both of the sites. We also want to start manufacturing HGPRs locally in Chile, as we do in Peru, and are looking to diversify into new product areas in South America such as truck final drive repairs and to carry out structural repairs of heavy components, including stress relieving. ■



Carlos Lahura

Managing Director – Andean Region SKF GROUP

Which of the sub-segments of the industry that SKF supplies bearings to have shown the strongest demand in recent years?

We have seen great demand for bearings in the comminution stage. SKF has invested in new technologies like the SKF Cooper solution for conveyor pulleys, which have been very well accepted in the market because it helps to reduce the contamination due to our triple barrier technology and in the same time reduce the time needed for maintenance by including a split bearing. This innovation for this critical application results in significant reductions in downtime and immense savings in plant maintenance.

What are the main market trends you have noticed in the bearings segment of mining in 2022?

The bearing market is extremely competitive. Commodities prices (like copper) are experiencing a high price cycle so mining operations are striving for a higher production output, and this means that the number one priority for bearing manufacturers and distributors is securing the availability of components to supply operations.

Can you elaborate on SKF's automated machine learning solutions for predictive maintenance, and hardware for condition monitoring?

SKF ventured into the world of AI and machine learning approximately two years ago with the acquisition of a start-up Israeli company called Presenso. Today, we can offer an automated machine learning solution which is mainly focused on automatic anomaly detection and the prediction of failures.

In Chile, SKF is the leader in condition monitoring hardware. We have more than 20,000 installed monitoring points in the country, comprising of both online and portable systems, which are supported by local repair and calibration facilities to deploy hardware and support customers.

Another big step towards this technology area is our recent collaboration agreement with Amazon Web Services, Inc (AWS) to deliver an easy-to-use and easy-to-scale condition monitoring and analysis solution that makes the ability to collect and analyze data using machine learning technologies available to a wider range of applications and customers. ■

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Wear Protection Solutions

Inflation is forecast to be higher than 9% in Chile in 2022, mirroring a global trend of higher costs caused by supply chain delays and geopolitical tension. Demand for mining machinery has remained robust, but guaranteeing timely and affordable supply has been a challenge. In this respect, solutions that can increase the wear life of equipment have become more valuable.

“Rema Tip Top has been known for many years as the Mercedes-Benz of wear protection – our solutions make products last longer – and we have kept this reputation to this day,” stated José Castillo, managing director of Rema Tip Top Chile, who spoke of the ratio between the cost and the price of a product, which equates to a total effective cost. “Some of our products might cost more than the competition but last twice as long, which means the total effective cost is less,” he said, explaining that because of the quality of Rema Tip Top’s products and the fact they are embedded with wear protec-

tion solutions, the company does not compete in the cheap rubber market where clients do not necessarily request such high quality.

A Chilean company with a wide range of wear protection solutions is Fourthane, which created products for the quick repair of conveyor belts, in addition to having a range of products for lining mining equipment and components. Eduardo Fajre, Fourthane’s commercial manager, elaborated on the company’s evolution to cater for more varied mining processes, including abrasion and impact resistant products for flotation cells, chutes, agglomerating drums, bucked wheel excavators and pulley linings, among others.

Fajre revealed that Fourthane doubled its international client base in 2021, with customers in North and South America, Europe and Africa. He gave an example of where the company channels its innovation: “One of our focus areas is anti-wear coating for some components and parts used in flotation and grinding plants. For example, we

can extend the life of SAG Mill trommels from 30 days to up to 90 days.”

High-Res Tecnología Antidesgaste (High-Res) is another Chilean company dedicated to the development and manufacturing of innovation in the area of anti-wear coatings for abrasion, impact or corrosion. Rodrigo Diaz, general manager of High-Res, spoke of the company’s work with Codelco at Chuquicamata on the first production line for crushing, before when Codelco has been having issues with the process, stopping every 15 days to change the coating in the middle conveyor belt. “Stopping a mining operation for eight or nine hours every 15 days is too much, so we proposed a solution – a High-Res design using rubber, plasma and tungsten carbide – which meant operations stopped only once every three months, rather than every 15 days,” said Diaz, adding that High-Res is now working on the entire line of wear products for Chuquicamata, and in certain areas can improve equipment wear from 20 days of durability to over six months. ■



Eduardo Fajre

Commercial Manager
FOURTHANE

Can you introduce Fourthane?

Fourthane has been in the market for 26 years. Since our products had such success and achieved great results, we decided to expand internationally and, during the pandemic, we installed several offices and warehouses in Arequipa, Peru. We also opened Spain, where we handle the markets of northern Africa, Europe, and the Kazakhstan-Russia segment, which is currently stalled. Every product Fourthane develops is made in Chile.

We are working in several segments within mining projects, mainly focused on preventative maintenance and extending the useful lifespan of components, particularly those exposed to abrasion. One of our focus areas is anti-wear pre-coating for some components and parts that are used in flotation plants. For example, we can extend the wear life of linings from 30 days to up to 90 days. We are also focused on preventative maintenance, such as our flagship Fourthane Red prod-

uct for conveyor belts. It costs slightly more than some of the alternatives in the market, but the results have been industry-leading.

How is preventive and corrective maintenance improving productivity at mine sites?

Let’s look at the care of a conveyor belt. When you have a slightly damaged component and you ask the maintenance professional if you can operate with said damage, he will say ‘yes’. However, when he actually has to fix it, a repair that was 10 cm x 10 cm is now 30 cm x 30 cm, and he will receive more for a bigger job, so he has that incentive. If you apply our product, the breach will require less costly and quicker intervention. We perform an analysis of whether it is more convenient to keep, or not repair the damage, and wait for the replacement of the belt, which evaluates costs in operation delays as well as the price of the replacement itself. ■



José M. Castillo

Managing Director
REMA TIP TOP CHILE

What are the main trends you have noticed in the Chilean market for material handling and processing?

We have witnessed that customers prefer to deal with as few providers as possible. This means that to some extent we have to form joint ventures or expand our capabilities. For example, looking at conveyor systems, historically you were hired as a specific niche provider to supply and repair only the belts. Today, customers require not only supply and repair, but also mechanical, engineering, and monitoring services. Rema Tip Top understands that we have to focus our strategy to become a one-stop-shop provider, which involves increasing capacity to supply a complete package for all end users.

To what extent is remote monitoring for conveyor belts improving productivity at mine sites?

Monitoring systems are key for safety – eliminating the need for people close to the system. They also improve productivity, as operators know when the belts are worn out, damaged, or need replace-

ment. Rema Tip Top has developed high-tech equipment for remote monitoring systems such as scanning and x-rays.

Ultrasound devices which have sensors are used to measure the thickness of a conveyor belt, as these belts get worn and erode over time, and you need to ensure that you do not reach the steel cable that reinforces the belt on the inside. As technologies have evolved and advanced over the years, measurement has become more accurate and efficient.

Where would you like to see the company by the end of 2023?

Rema Tip Top in Chile would like to see substantial growth moving forward – both organic and potentially inorganic. Although the current political situation is a little concerning, we remain optimistic about Chile and that the mining industry will continue to be the industrial and economical driver of the country.

When you work with Rema Tip Top, you work with extremely integral people which will do their utmost to achieve the best success for customers. ■



Carlos A. Ramírez

General Manager – Chile & Peru
JOHN CRANE

How do John Crane’s solutions keep critical rotating equipment operating for longer and reduce water consumption?

In mining, due to the complexity and harsh environments that rotating equipment are used in, generally we see very short life cycles. On one side the pump manufacturers, such as Weir Minerals, Metso and FLSmidth, are trying to extend those life cycles and therefore increase the uptime of the equipment, through new material technology. John Crane works with these companies on solutions including mechanical seals, which can last up to 18 months and do not use water. Although they require a bigger capital investment initially, mechanical seals are a much more robust technology than traditional packings, which last between one and four weeks. John Crane’s T-5860 seals with diamond faces technology do not require water for lubrication, so it is a game-changing development.

We complement these solutions with pilot plans that we are currently developing because, within John Crane’s acquisitions in the last ten years, we have broken

into the world of filtration for high-value processes, particularly related to hydrocarbons and fuels. We are involved in the development of multi-purpose filters (MPF), focused on water that is used for sealing solutions in mining industry.

What is your strategy to gain market share in Chile’s mining market in the years ahead?

I have recently moved to Santiago to help John Crane replicate the success we have had in Peru, going in an eight-year period from invoicing less than US\$500,000 to more than US\$2 million per year in the mining sector. We are focusing on technological superiority and reducing two variables that cause the greatest concern: water and energy usage. Our engineers are expertly trained in installation, performance and measurement, as well as after-market service. Finally, our service contract model allows for companies with different budgets to utilize John Crane’s technology. In the end, we want to maximize uptime and improve the TCO (Total Cost of ownership) of an asset. ■



“My experience at Codelco and BHP made me see that mining companies are thinking outside of the box, because nowadays, if you continue producing on deposits in the traditional way, you are going to hit a plateau, especially at some of the older mines in Chile.”

- Oscar Castañeda,
General Manager – Chile & Argentina,
Orica

SERVICE PROVIDERS

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Image courtesy of MAXAM

Drilling & Blasting

Demand for drilling services and equipment is booming but human resources are scarce

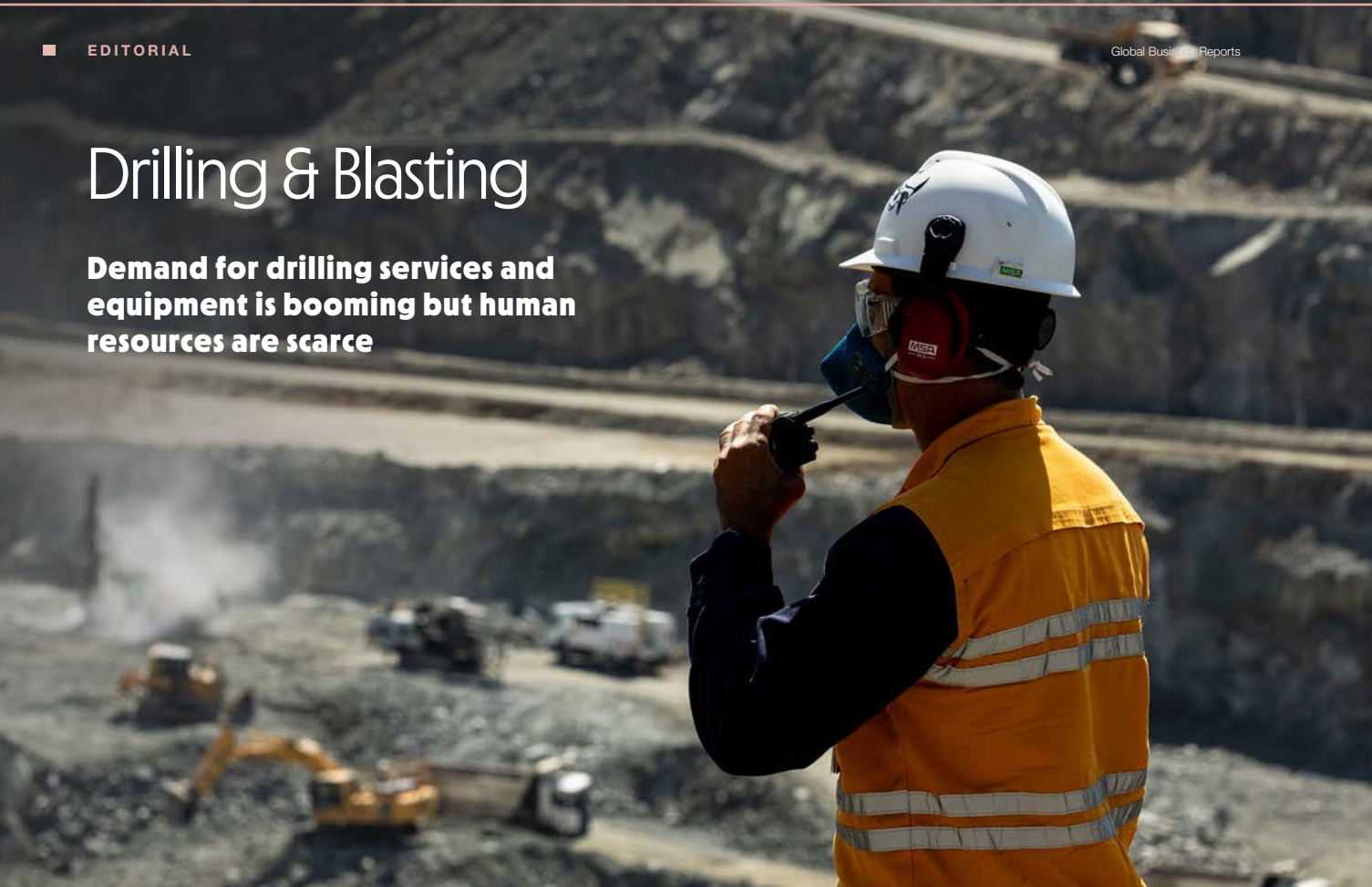


Image courtesy of Applan Capital Advisory LLP

The drilling sector experienced one of the sharpest rebounds as lockdown restrictions were eased in 2021. Surging metals prices stimulated investment into production drilling by majors looking to take advantage of high copper prices, and the junior sector reignited, looking to add value through the drill bit. However, ruptures to global supply chains, a scarcity of raw materials and a dearth of trained professionals to meet rising demand have presented challenges.

“We have seen an exponential rise in the demand for drill rods in the past 12 months,” observed Tomás Buttazzoni, general manager of Technosteel, a manufacturer of drill rods for exploration and large diameter rods and accessories for blasting. “In fact, it has been a demand that has been difficult to meet because of the lack of availability of raw materials. Steel suppliers have not given an appropriate importance to the mining industry because they give more importance to the oil and gas and automotive sectors.”

Buttazzoni mentioned that a lack of qualified labor has also been a challenge, as industrial operators that are qualified to the level required are increasingly scarce in Chile.

“Shortages of workforce is a global problem affecting most industries. It has been a challenge to train professional drillers and helpers, considering that it not something that you can study at high school or college,” said Cristián Correa, general manager – Chile for drilling contractor Geotec Boyles Bros, which has approximately 30% of the market share for drilling in Chile.

Correa noted that some technical degrees help to form prospects into drillers, but these are careers that are really

formed in the field. He added: “To tackle this challenge, we have implemented a drilling platform training center, where we train field personnel, simulating day and night shifts, 24 hours a day, seven days a week just like in the field.”

Considering the robust outlook for metal demand moving forward, innovation is necessary to reduce the reliance on manual labor in the drilling and blasting space, as well as to remove workers from harm’s way so processes become safer. Buttazzoni mentioned that demand has been strong for Technosteel’s Safedrill rod manipulation technology, called rod handler: “Mining companies in Chile have adopted this as a standard, as they no longer want people to be in direct contact with moving rods and parts.”

To illustrate Geotec’s position as one of the main innovators when it comes to drilling technology and equipment, Correa gave the example of how the company introduced and improved rod handlers to be completely automatic, eliminating contact between man and machine by 100%. “This has prevented hand injuries, which used to be a real issue for companies in the drilling business.”

Correa added that Geotec has created treatment plants for tailings, including a centrifuge plant to separate solids from water to reuse the water, as well as pressurized cabins to protect personnel from machines and the elements.

Diamantina Christensen has over 50 years’ experience in the development, design and manufacturing of drilling products, and supplies Geotec (its sister company) with almost 90% of the drilling products, according to Ignacio Bello Marambio, general manager at Christensen Chile S.A. Discussing the im-

portance of making drilling campaigns as productive as possible by reducing idle time during the changing of drill core bits, Christensen has focused on its manufacturing processes to achieve 25% better performance. “In our rod production line we have automated processes for heat treatment and threading units that require no direct intervention of people, after which we coat the threads. Finally, we have a process of shipping and distribution,” said Bello Marambio, adding that Christensen has the capacity to supply internal demand and export to the main countries in the region.

Drillco is another Chilean company in the drilling equipment space that has been active for over 50 years, and today has seven offices worldwide. Javier Varela, CEO, explained that the company differentiates itself by observing operating conditions and making modifications in collaboration with clients to achieve better performance. He elaborated: “This involved a lot of studies to understand variables such as the rocks, the conditions that the equipment works under, how they operate with compressors, etc.”

Trinidad Carmona, Drillco’s sales and marketing director, gave the example of an automatic replacement system for drilling components that the company developed with one of its mining partners: “The operator, with the press of a button, can go through the entire process of replacing the component, which reduces the replacement time from around 55 minutes to 3 minutes, as well as eliminating the risk to the personnel and reducing energy usage.”

Innovation in the blasting space

Over the years, the blasting and explosives segment of the mining sector has evolved to become safer, more accurate, and less labor-intensive. Aristides Álvarez Velasco, Maxam’s regional manager for Latin America, spoke of the trend of obtaining more actionable data from each area of the blasting process. He cited Maxam’s X-energy innovation, a digitalization and control system for blasting and drilling. X-energy includes series of tools such as X-Rock and Smart Rioflex, that allow clients not only to know what kind of rock they have in a zone, but also what kind of rock they have within a borehole.

“Based on the data you get from drilling and the digitalization of the system you can modify our product for each section of a blast hole, which allows you to optimize the blast perfectly in a way that gives you savings further along the production process,” said Álvarez, adding: “The big mining and explosives companies are all focused on digitalization, data capture and analysis to make the art of blasting more of a science.”

Discussing robotics and automation in the blasting space, Marco Ruiz Hernández, robotics director at Enaex, commented that the benefits depend on the specific situation. “In some cases, technology can add productive hours to the chain, resulting in increased throughput of mines and thus more profitability,” he said, giving the example of when weather conditions such as fog or rain impact human productivity.

He also mentioned the safety aspect of removing humans from dangerous situations by conducting operations from

a control room, adding: “The maximum potential of these technologies can be reached if you have all the processes interacting with each other in an autonomous way.”

Ruiz went on to reveal that Enaex has partnered with Codelco at El Teniente to deploy its autonomous solution for remote loading in an underground environment: “In April 2022, Enaex performed the first remote blast in an underground environment at El Teniente with our UG-iTruck, without any human interaction at the mine site – a huge milestone as it is non-precedented worldwide.”

Blasting specialist and technology company Orica has collaborated with Swedish OEM Epiroc to create Avatel, the first fully mechanized development charging system. The company is currently trying to implement Avatel at projects in Chile and expects this to materialize in 2022, according to Oscar Castañeda, Orica’s general manager for Chile and Argentina. “My experience at Codelco and BHP made me see that mining companies are thinking outside of the box, because nowadays, if you continue producing on deposits in the traditional way, you are going to hit a plateau, especially at some of the older mines in Chile,” observed Castañeda, who also emphasized the collaborative nature of innovation, giving the example Fundación Chile, a mechanism of rapprochement between mining companies and technology companies, and entrepreneurs and universities to connect and combine capacities. “It is a cultural change that has been taking place in recent years,” he added. ■



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geotec@geotec.com.pe

Ecuador

- Quito

eguerra@boytec.cl

Can you introduce Geotec and describe the company's range of drilling services in Chile?

Geotec Boyles is a drilling company with an approximately 30% share of the Chilean market. It is part of the Boytec Group, which also operates in Peru, Mexico and Ecuador. We work with a fleet of around 120 drills, providing services for diamond core, reverse circulation, horizontal drain holes, water wells for production and dewatering, as well as water well field management.

We have seen significant demand for diamond drilling from BHP, Collahuasi, Anglo American, Antofagasta Minerals, Codelco, Peñoles, Barrick, Anglo American and other operators.

Many companies have spoken about the shortage of qualified drilling professionals to meet demand. How are you dealing with this challenge?

It has been a challenge to train professional drillers and helpers, considering that it not something that you can study in high school or college. To tackle this challenge, we have implemented a drilling platform training center, where we train field personnel, simulating day and night shifts, 24 hours a day, 7 days a week, just like in the field. It is not a quick process because of the high safety standards required by our industry. Geotec does not place field people on jobs unless they are completely certified to operate the equipment and demonstrate total compliance with procedures and policies. Therefore, with adequate training all contracts are currently being executed successfully.

How are innovations such as increased mechanization improving safety in the drilling process?

Geotec is one of the main innovators when it comes to drilling technology and equipment. We introduced and improved rod handlers to be completely automatic, eliminating contact between man, drill and tools by 100%. This has prevented hand injuries, which used to be a real issue for companies in the drilling business. We also developed drilling fluids treatment plants to clean and reuse mud with systems like centri-cleaners and centrifuges, to separate solids from water, thus saving water usage. Another important innova-



Cristián Correa

General Manager – Chile
GEOTEC BOYLES BROS



Through building long-term relationships with major clients they see the value in paying for safety and quality, which is what Geotec offers.



tion is the pressurized drilling cabin to protect our personnel from the weather, noise, dust and other elements.

What are some of the standout mining projects Geotec has worked on in Chile?

BHP has a vast drilling program that includes diamond drilling, reverse circulation, water wells and drain holes, for its Escondida mine. Our drilling contract at Escondida has been extended until 2027. Another very important long-term drilling contract for us is at the Collahuasi mine, and this includes diamond and RC drilling and water wells. We are also involved in a large project at Codelco's Radomiro Tomic mine, where we currently have 15 diamond drills working. Finally, Antofagasta Minerals have been our client for almost five years and we have formed a very strong relationship.

Considering high metals prices in the last two years, would you say clients are now more concerned about quality instead of cost?

The issue with prices is relative, because although the copper price is high, costs for companies have also risen significantly. In Chile like in many parts of the world, we are expecting that inflation in 2022 will be above 10%. Clients are understanding be-

cause they face the same problem. Inflation affects salaries, fuel, equipment, drilling tools - just about everything on a drilling operation. Another negative cost impact is the costs of freight, domestic and international sea freight prices. In such a context, price is still an important factor. However, through building long-term relationships with major clients they see the value in paying for safety and quality, which is what Geotec offers.

Which areas of the business would you say offer the best opportunities for growth for Geotec?

Diamond drilling will always thrive because it is the heart of the mining industry – it brings the most representative sample of the minerals, especially now that we are working with producing mines. Besides this, mine dewatering is coming on strong as water needs to be removed from the pits. As mine pits get deeper, it is inevitable to stumble upon underground water, water that will interfere with mine operations. I think that there are some opportunities to develop technologies to tackle this water problem in a better and more efficient way. Drilling water wells to supply mine plant operations will tend to decrease in the future as these water wells are being replaced with seawater from desalination plants. ■



Tomás Buttazzoni

General Manager
TECHNOSTEEL

Can you tell us about Technosteel's range of solutions?

The Technosteel group engages in three segments: Technosteel is focused on the manufacturing of drill rods for exploration and large diameter rods and accessories for blasting.

Another segment is served by Polimet which designs and manufactures conveyor or belt equipment and components.

Our third company is Safedrill, which produces rod handling equipment and solid separation mud plants for diamond drilling operations.

In all three companies we use the same focus on strong in-house engineering and design software, intellectual property and high-quality production in our 20.000 m² plant in Santiago, Chile.

How has the demand for drill rods evolved in the last two years?

We have seen an exponential rise in the demand for drill rods in the past 12 months. In fact, it has been a demand that has been difficult to meet because of the availability of raw materials. A lack of qualified labour has also been a challenge.

Can you give provide an overview of Diamantina Christensen's capacity in Chile?

Our main product lines are drill rods in different diameters, diamond products and core barrels parts and accessories. We have a manufacturing plant in Santiago with a high capacity for rod manufacturing. It also has the capacity to manufacture diamond products. Core barrel parts and accessories is also an important product line of the plant.

In which new drilling technologies has Diamantina Christensen been investing?

In terms of our line of diamond products, we decided to make an important investment in new technologies because our clients – drilling services contractors – require to drill deeper in more complex ground conditions with high presence of abrasive elements, which results in a need for diamond products such as core bits that could increase productivity. We made an investment in the transformation and incorporation of controlled atmospheres furnaces, which allowed us to have a high-quality product with much better perfor-

There has also been robust demand for the Safedrill rod manipulation technology, which we call the rod handler. Mining companies in Chile have adopted this as a standard, as they no longer want people to be in direct contact with moving rods and parts.

How does your equipment help mining companies become more productive?

Our main contribution to making mining easier is through fine-tuned design and production quality. Technosteel is a company with a very high degree of specialization and the highest standards of engineering and production. Our engineering team often offers improvement to specification of products being used by customers, impacting in more meters drilled, more material transported, and higher safety to operators. When it comes to metal working, our metallographic lab ensures we are always working with materials that are in optimal condition. Our way to make mining easier is to give miners products that serve their purposes and are durable, which results in greater efficiency. ■

mance. We have had a great response from our clients both nationally and internationally with this new technology.

What is Diamantina Christensen's strategy to maintain its market share in the drilling product market?

Diamantina Christensen likes to approach clients at different levels, from management teams to field operators and drillers. We want to be consultants in supplying the right drilling products that fit the specific ground conditions of the project, which allows us to capture their needs as end users, from the driller to the general manager. We always seek first for a technical validation of the products. In these times with the current supply chain challenges, we have also worked with our clients to have planned requirements, to change the old mindset of ordering something and getting it the next day, because that is something that no longer happens. It is necessary to work hand in hand in the field with clients and also with the supply chain and planning departments so we can have the proper products at the right time. ■



Ignacio Bello Marambio

General Manager
DIAMANTINA CHRISTENSEN
CHILE S.A.

What are some of the standout open pit and underground projects that Enaex has been involved in?

MRH: In open pit mining we are deploying our remote operation technology at a big productive mine near to Santiago and have now switched from a trial period to a more steady operation where we are implementing remote loading of blasting agents. I strongly believe that this is only the first step of the technology deployment; we can start thinking about a fully remote operated mine and integrating our system with other remote fleet or equipment. We have many options and future developments of our technology at open pit mines, ranging from remote operation, autonomous operation, and integration with other processes such as drilling and haulage.

Related to underground mining, Enaex has partnered with Division El Teniente at Codelco to deploy our autonomous solution for underground mining – we will implement our remote technology for autonomous loading for tunnel development in an underground mine. In April 2022, Enaex performed the first remote blast in an underground productive mine in a demonstrating phase with our UG-iTruck without any direct human interaction in the process at the mine face – a huge milestone with no precedent worldwide. We are continuing with testing activities and getting the authorities approvals to start a trial period of this technology in Codelco.

Could you provide examples of how the explosives and blasting space is becoming more sustainable?

PW: A particular example is the project we are developing to use green hydrogen produced from electrolysis using renewable energy to produce green ammonia, which is the main raw material for our blasting agents. Another example is the use of real data and innovative solutions to optimize the design and execution of the blast, making it more productive and therefore consuming less resources.

MRH: Regarding green ammonia, Enaex recently submitted the ammonia processing plant construction



MRH



PW

Marco Ruiz Hernández & Pablo Wallach

MRH: Robotics Director & PW: VP Innovation & Marketing
ENAEX

project as a part of “HyEx – Ammonia Synthesis”. This project will be the first green ammonia production plant in Chile with an annual production of 18,000 t/y created from green hydrogen and renewable energy. It will serve as a pioneer in the implementation and study of new technologies and efficiencies in the production of ammonia. The ammonia produced will be used in the Enaex plant in Mejillones, Chile, to produce ammonium nitrate, a fundamental element to supply the requirements in the blasting processes for the mining industry.

The plant is part of the HyEx project developed jointly with Engie, whose objective is to use the region’s high renewable energy potential to produce a carbon-neutral fuel that will make it possible, at a competitive cost, to replace fossil fuels in the future and thus contribute to the decarbonization of the atmosphere.

The most important thing for us is to be able to contribute to the development of green and carbon-neutral mining. This project alone will mean a reduction of 30,000 t/y of CO2 equivalent and, if we are then able to develop its second phase, considering the complete ammonia consumption of our plant, it will reduce more than 1 million t/t of CO2.

When it comes to robotics, can you explain the ways in which productivity and safety can be improved?

MRH: The benefits of robotics and automation depend on the specific situation. In some cases, technology can add productive hours to the mining value chain, resulting in increased throughput of mines and thus more profitability. Robotics and automation can lead to increased productivity and safety in operations as the human factor is taken out of dangerous situations and put in a control room from where operations can be conducted. The maximum potential of these technologies can be reached if you have all the processes connected and interacting with each other in an ecosystem of autonomous machinery.

An example of this is what Autonomous Solutions, Inc (ASI) is doing in the conception and the design of management tools to integrate remote equipment for the autonomous mines of the future. ASI is one of Enaex’s key partners and we are working to integrate all the links (especially the blasting) in the chain related with the mining process and reach a new and better global optimum. Remote operations and robotics challenges us to train and develop professionals with higher skills and increase the quality of people’s lives. ■



Oscar Castañeda

General Manager – Chile & Argentina
ORICA

How has Orica evolved to become a technology company as well as a blasting specialist?

Orica is focusing our efforts to leverage our strengths and create opportunities for growth beyond blasting. We are a company that delivers integrated solutions with a high level of digital solutions development. As well as all the technological developments related with mining process from drilling to plant, we have different applications, for example, a solution called Rhino which captures drilling information, helping to predict characteristics of the rock and its impact in blasting improvements. We also offer technologies like FRAGTrack that allow us to understand what is happening with rock fragmentation, helping the customer to take decisions, and making the process safer and more efficient. The Integrated Extraction Simulator (IES) is the newest addition to our digital offering. It is an advance in the technology of mining and mineral processing simulation and optimisation. It’s like having the equivalent of a mining industry smartphone and running all kinds of mining and mineral processing apps on it.

Can you elaborate on Orica's partnership with Epiroc to develop the world's first semi-automated explosives delivery system?

This technology was developed by Orica and Epiroc. Avatel™ brings together the best of both, this is the first fully mechanised development charging system and we are currently trying to implement some Avatel projects in Chile and expecting to materialize it during this year. It is a more automated system allowing also to reduce people in the firing line, which we believe will contribute greatly to mining operations from the point of view of safety and productivity. The capabilities that Epiroc has for underground drilling and Orica has for blasting are a valuable combination.

Which areas of Orica's business in Chile do you see as having strong potential?

While progress has been made on blasting issues in the mining sector, there is still a lot to do to fully integrate this process with drilling and the plant or even other process. With technology we can add value to that whole package without losing sight of what happens at each stage along the way to the plant. ■



Arístides Álvarez Velasco

Regional Manager – Latin America
MAXAM

Can you give an overview of MAXAM's presence, activities and capacity in Chile?

Chile is the most important jurisdiction for MAXAM in Latin America. We have three manufacturing plants and storage fields for ammonium nitrate, the basic raw material for explosives. Together these can supply practically the entire Chilean market. Within the Latin America market, we are present with production plants and storage in Bolivia, Chile and Peru, and we sell to pretty much all countries in the region. MAXAM currently supplies all of Escondida’s explosives, and we are also present in Lomas Bayas and Caserones. We will soon be applying our products in a number of mines for demonstration purposes. We also have several smaller clients.

What are the main trends MAXAM sees shaping innovation in blasting technologies today?

MAXAM’s biggest bet is X-Energy, a digitalization and control system for blasting and drilling. There is a series of

tools like X-Rock and Smart Rioflex that allow you not only to know what kind of rock you have in a zone, but also, what kind of rock you have within a borehole. Based on the data you get from drilling and the digitalization of the system you can modify our product for each section of a blast hole, which allows you to optimize the blast perfectly in a way that gives you savings further along the production process.

That is the future: capturing more data and analyzing it to use in selecting trucks, giving you more flexibility in the kinds of trucks and explosives, and producing better results further down the process to save not only on explosives, but also for treatment, transport, etc.

Does the company have plans to expand in South America?

Our plan is to expand, but in Chile we do not need a lot more production capabilities, but we will invest in equipment as necessary, and there are important investment projects in other countries like Bolivia and Peru. ■

Laboratories & Chemicals



Image courtesy of SQM Laboratories

The breadth of the mining value chain goes far beyond the EPCM firms and OEMs that receive the headline contracts with major producers. Mature mining jurisdictions, with Chile being a leading example, have fostered an ecosystem of suppliers that add value to operations with a wide array of services, from laboratories and chemicals, to logistics and accommodation. The pandemic has highlighted the critical importance of robust domestic supply chains, and services companies with local capacity are reaping the benefits.

SGS, the global leader in testing, inspection and certification (TIC), offers services for the full lifecycle of mining, covering exploration, production, decommissioning and closure. Mauricio Rocha, managing director of SGS Chile, detailed the company's chain of services starting with ore characterization, to process optimization, through to the certification of final products at the ports ready for shipment. "This is a complete value chain that goes through chemical labs, engineering, metallurgy, geology and plant operations."

Rocha explained that rather than offer simple services, SGS has large contracts taking on the whole process from pit to port, including with BHP at Escondida, as well as taking on the whole north district for Codelco.

On a global level, laboratory bottlenecks have been a feature of the pandemic, with both producers and juniors commenting on the slow turnaround times for assays. "There was not enough service capacity globally to supply such great demand, and this was compounded by government restrictions," acknowledged Rocha, who also pointed to the trend of mining companies requiring more analysis and sending more samples as projects are accelerated to take advantage of high metals prices. He added: "SGS is in a better position than most to deal with this, as we have in-

stalled capacity and laboratories across Chile; mobile labs as well as regional labs in Peru."

Elaborating on the lab needs of large operations, Rocha gave the example of BHP's Spence, which has to calibrate the start of a new concentrator, requiring a whole range of analysis and development: "Those samples go to our commercial labs, and they require in-line analysis because they are calibrating their plant and any deviation is a loss of a lot of money when production magnitudes are huge."

Rocha noted that this requires labs at the mine site with a capacity to receive and respond in-line, as well as external labs to check and make longer-term analysis.

The chemical industry shares a common struggle of public perception with mining – both sectors are necessary for everyday items we take for granted, but neither are generally thought of in a positive light. In reality, responsible chemical use has a multitude of benefits, from increasing crop production to feed a growing global population, to improving metal recovery or treating water in the case of mining.

Ricardo Capanema, global marketing director mining solutions at Solvay, spoke about Solvay's global plans to grow in the copper business: "Solvay is evaluating the investment in capacity building to meet increasing demand for flotation chemicals. This is partly driven by the industry's decarbonization push."

Capanema expanded on how sustainability is a driving force in R&D, detailing how Solvay's solutions can help different areas of the mining business: "Additionally, we have developed solutions to help mining companies treat challenging ores that contain problematic penalty elements. We also help companies address their energy and water conservation, especially during the comminution stage." ■

What are SGS's main services for the mining industry and standout projects you have been involved in?

Approximately 75% of SGS's business in Chile is mining, with many of our standout projects related to the testing, inspection and certification (TIC), and modelling of mineral productive processes. We have a chain of services starting from ore characterization, going through optimization of all processes, and ending with the certification of final products at the ports and things related to shipment to the final clients. This is a complete value chain that goes through chemical labs, engineering, metallurgy, geology, plant operations.

Rather than offer simple services, we have integral contracts where we take on the whole process from pit to port. For example, we have a large contract with Escondida, and last year we took almost the whole north district contract for Codelco. This involved process optimization, port services, chemical labs, metallurgy labs and geological testing for all of Codelco's northern mines.

Global supply chain and logistics delays have impacted the time to receive lab results. How is SGS dealing with these challenges?

Most delays were due to Covid. Laboratories were not at full capacity, and faced complexities in responding to the demand that sometimes increased because of rising metals prices. There was not enough service capacity globally to supply such great demand, and this was compounded by government restrictions.

We have noticed a trend of mining companies requiring more analysis and sending more samples. First, because projects are being accelerated and secondly, since companies are accelerating their projects (some which were delayed due to Covid), the installed capacity of commercial labs does have not the capacity for all the samples they are receiving.

SGS is in a better position than most to deal with this, as we have installed capacity and laboratories across Chile. Here in Chile, we prepare samples for chemical analysis and send them to Peru, where they have a larger capacity.

How can SGS's mobile laboratories help mining operations situated in remote locations?



Mauricio Rocha

Managing Director
SGS CHILE



Mining companies are sending samples every two or three hours to laboratories, and they need quick responses in order to immediately move parameters in the processes.



In addition to assisting commercial labs, mobile laboratories offer shorter response times. Mining in Chile is practically all low grade, especially with old mines, where the complexity of minerals increases and demands more analysis to better understand minerology and improve processes. For that, labs need to process more samples with faster responses. Mining companies are sending samples every two or three hours to laboratories, and they need quick responses in order to immediately move parameters in the processes.

Operations like BHP's Spence, which has to calibrate the start of a new and very large concentrator, require a whole world of analysis and development; those samples go to our commercial labs, and they require in-line analysis because they are calibrating their plant and any deviation is a loss of a lot of money when production magnitudes are huge. This requires labs in the mine with a capacity to receive and respond in-line, as well as external labs to check and make longer-term, more robust analysis. Every mining company, when starting their projects, needs to have a laboratory nearby.

Considering all this demand, does SGS have plans to expand its capacity in Chile?

Definitely. We have two strategies: the

organic one, to increase our capacity and expand our laboratories. SGS's infrastructure today is already very large; we have more than 3,500 people and provide a full suite of services, but we intend to grow. It is straightforward for us to get approved Capex projects for infrastructure from our parent company in Geneva as they know the return on investment possible. On the other side, inorganic growth is always on the table. We have bought engineering companies like CIMM and Aquatic Health, and would consider further strategic M&A in the future.

Can you elaborate on SGS's approach and commitment to sustainability?

SGS's vision has evolved to incorporate sustainability into all aspects of the business, both internally and what we offer clients. The mechanism to face issues of ESG is innovation, including digital and structural transformation. As well as an internal innovation area, SGS has important alliances with universities looking into projects such as green hydrogen, as well as start-ups focused on hyperspectral imageology. Our pipeline of innovation projects related to sustainability has three pillars: risk management, consulting, and innovation. This approach and focus make us a strategic partner to mining which goes beyond just being a service company. ■



Ricardo Capanema

Global Marketing Director –
Mining Solutions
SOLVAY

How is Solvay increasing its capacity to meet growing global demand for copper, and which products are driving this growth?

Solvay's solvent extraction business line is in high demand because our unique solutions, such as nitrate resistant extractants, are being adopted by several customers and gaining market traction. We estimate to have an 85% market share in Latin America as we strengthen our supply capacity to meet customer demand, which is also driven by new mining operations in the region.

Concurrently, Solvay is evaluating the investment in capacity building to meet increasing demand for flotation chemicals. This is partly driven by the industry's decarbonization push, which places an onus on us to act as a leading company that supplies reagent technologies to meet the green demand.

How do Solvay's products increase the sustainability of mining operations?

We have reduced community and employee exposure to toxic chemicals by replacing xanthate with more friendly chemistry like a AERO formulations and

AEROPHINE. Another example is the replacement of NASH in the Copper / Moly separation with polymeric depressant technology. Additionally, we have developed solutions to help mining companies treat challenging ores that contain problematic penalty elements. We also help companies address their energy and water conservation, especially during the comminution stage. A criterion of success for every technical solution Solvay designs is its sustainability impact to ensure that we eventuate into a greener future.

Do you think the chemical and mining industries which Solvay works in are misunderstood from an environmental perspective?

Modern life requires infrastructure to transmit energy, which intensified the need for green metals. I believe all the big industry players and countries, such as Chile, understand the necessity of responsible mining. The pressure to decarbonize is a positive development on the industry, as it affords the opportunity to demonstrate our greener and sustainable solutions to the authorities and local communities. ■



Rodrigo Prado

General Manager
TECNO FAST S.A.

What have been the main milestones achieved by Tecno Fast in 2021 and 2022?

We focused on finishing the Quebrada Blanca 2 project. We also finished the camp and auxiliary infrastructure for Gold Fields' Salares Norte project and a special remark for the camp of Rajo Inca, Codelco, where we are not just building and renting the camp, but we are operating it, which is an entirely complete service, including administration, maintenance, operation and food and cleaning services. In Peru we have been working successfully in Yanacocha. In our newest division, Tecno Fast Montajes, we have been very busy, also working in Quebrada Blanca.

Our rentals line of business for commercial and industrial renting also saw a lot of activity, growth, and high utilization for Chile and Peru.

The most remarkable issue of the year was the acquisitions of Triumph Modular in Boston USA, and then Alco Rental Services in Barcelona, Spain. Both companies are dedicated to renting modular infrastructure.

What opportunities do you see for renewable energy projects such as solar farms?

Tecno Fast has worked very closely with solar and wind power projects, and we see a lot of opportunities in this space. We have developed several camps with Enel, and I think collaboration with the renewable energy sector is very important, because it will allow mining to have access to lower energy costs and be able to move towards green copper. It is a sector that has room to become more sustainable and greener, in line with the expectations and commitments that we have made.

Can you give examples of the latest technologies being utilized by Tecno Fast?

We have incorporated cutting edge technology in the factory, including automating the entire fabrication process of the modular structures. With this, we have not just automatized production processes but we have widened the catalogue of solutions that we offer. Historically, we delivered solutions in wood, but now we can deliver them in light steel as well. ■

Infrastructure & Logistics

Chile is known for its large-scale mining projects, which offers opportunities for companies involved in the provision of infrastructure and mining camps. Tecno Fast S.A. has worked on many of the emblematic mining developments in recent years, including QB2 for Teck, the camp and auxiliary infrastructure for Gold Fields' Salares Norte project, and Rajo Inca for Codelco. "We are not just building and renting the camp, but we are operating it, which is an entirely complete service, including administration, maintenance, operation, food and cleaning services," commented Rodrigo Prado, Tecno Fast's general manager.

Evaluating Tecno Fast's potential for growth in the mining market in the coming years, Prado stated he expects a lot of activity, including a camp for Collahuasi of around 6,000 beds, as well as the Centinela project. He added that the company sees opportunities in delivering value-added products: "Not just delivering the camp but also managing, administering, operating it and adding services. This is supported by

the digitalization of our processes and the use of data."

One of the most evident themes of 2021 and 2022 has been the rising cost of logistics, ignited by the pandemic and enflamed by rising inflation and fuel costs. Tomás Valenzuela Somerville, mining and energy director of AGUNSA Chile, the multinational logistics company, remarked that while everyone is dealing with this scenario, AGUNSA has tried to be as flexible as possible to search for efficient alternatives. "Logistics companies need to be creative. For example, as the price to send a truck to a mine has gone up, we can offer to do less trips but more efficiently and with a bigger cargo."

Valenzuela noted that due to AGUNSA's vertical optimization and network of logistics centers, the company has managed to help mining clients save costs. "We are just in front of Puerto Angamos in Mejillones, and we are considerably more efficient and competitive than other alternatives in the region, so clients can save up to two digits at the best level of quality and compliance in the market." ■



Tomás Valenzuela Somerville

Mining & Energy Director
AGUNSA CHILE

Can you introduce AGUNSA?

AGUNSA is a Chilean multinational company with offices and operations in more than 20 countries. We are a recognized leading company in agency and logistics services. We have successfully created an integrated logistics platform that enables our customers to make their businesses grow by working efficiently across many different locations and scenarios. We currently have more than 35 long term contracts in Chile and Peru in the mining industry, 5,000 collaborators, US\$610 million in annual sales, 400,000 square meters of warehouses, 430,000 truck trips per year and more than 30 million tons mobilized per year in ports.

What involvement does AGUNSA have with the mining industry, and which standout mining projects and clients has the company worked with in Chile and Peru?

We provide logistics services to mining, energy companies and their suppliers. These services include international transportation, port operations, vessel agencies, storage and road transport of

general and oversized cargo. Additionally, we provide services within mining operations, such as drilling and blasting, loading and haulage, operation of leach pads, and maintenance of plants. In addition, we operate private maritime terminals for mining companies, such as CAP, Codelco, Collahuasi, SPL (former K+S) and Cordillera, to mention a few.

Can you tell us about AGUNSA's environmentally focused initiatives to decrease GHG emissions and contribute to more sustainable operations?

In sustainability and circular economy, we are working very hard on four pillars: care for the planet, social development, powering our people and operational excellence. Our commitment translates into responsible environmental behavior, through efficiencies, promoting the use of green energy, clean production agreements (APL), waste management and recycling plans, amongst others. Our focus last year was to measure our Co2 footprint considering of all our operations, and this year, we are working on the establishment of our specific sustainability pillar plans. ■

Image courtesy of Teck Resources

Concluding Thoughts

During our research, we speak to business leaders across the value chain to gain an understanding of the state of the Chilean mining industry based on their experiences. Through what amounts to several hundreds of conversations, we compile a database of valuable knowledge on a range of important topics. In these pages, we have chosen a brief selection of quotations that we feel best summarize some of the challenges and opportunities the industry should expect to encounter going forward.

“Chile has an enormous opportunity to be a very relevant player in the fight against climate change via the supply of minerals such as copper, lithium and cobalt. The country’s investment portfolio stands at US\$60 billion, which is remarkable. The challenge is to execute these investments. To achieve this, it is essential to have regulatory stability, as these are long-term investments.

We also need to meet environmental challenges, and a key challenge surrounds water consumption. Right now, Chile’s mining sector only uses 3.5% of the country’s water and we recycle 76% of that. However, we intend to improve this, and have a commitment to source 50% of our needs from seawater by 2030.”

- Joaquín Villarino, CEO, Consejo Minero

“The mining sector has the potential to be right at the center of the changes that the world urgently needs. Take copper as an example: copper producer countries can choose to play a substantial role to underpin the global megatrends of decarbonization, electrification and renewable energy. This is a unique opportunity. So when I say that the industry is at an inflection point, it means that we need to decide whether or not we are willing to take the right actions at the right time for saving the planet for future generations.”

- Rag Udd, President Minerals Americas, BHP

“For many mining companies, tailings represent an inherent long-term responsibility and an environmental liability. On the other hand, grades are getting lower and the industry needs to look at ways to maintain production levels. The notion of tapping into tailings to derive further economic value is very compelling. However, producing copper from tailings is not easy and requires art and science, as no two deposits are alike. For example, even at MVC we have had to make adjustments to fine tune the processing of the fresh and historical tailings from El Teniente. I think that when the right decision makers at mining companies start adjudicating the potential value to their existing tailings and seeing them as an opportunity to top up production, rather than just a liability, there could be tremendous opportunities.”

- Aurora Davidson, President & CEO, Amerigo Resources

“Regarding mining royalties, if legislature suggests that companies should pay based on their sales and not based on the operating margin, then we have a problem. A site that has a cut-off grade of 0.3% or 0.4% Cu is not comparable with another that has a 1% cut-off grade. Each operation has its own intrinsic conditions and performance levels. To our surprise, every time we meet with deputies and senators, it is difficult for them to understand the concept of a sales tax vs an operating margin tax. We have to think that we live in a global village, and if Chile has a tax level that does not allow the mining sector to be relatively profitable, we will not receive investment.

In the last 15 years there has been a level of remittances in the order of US\$120 billion from mining companies to their subsidiaries as profits, but nobody remembers that in the same period there was also US\$120 billion in mining investment. Those investments remain in the mining ecosystem that not only benefits suppliers of all sizes, but also those who live from this chain.”

- Philippe Hemmerdinger, President, Association of Industrial Mineral Suppliers (APRIMIN)

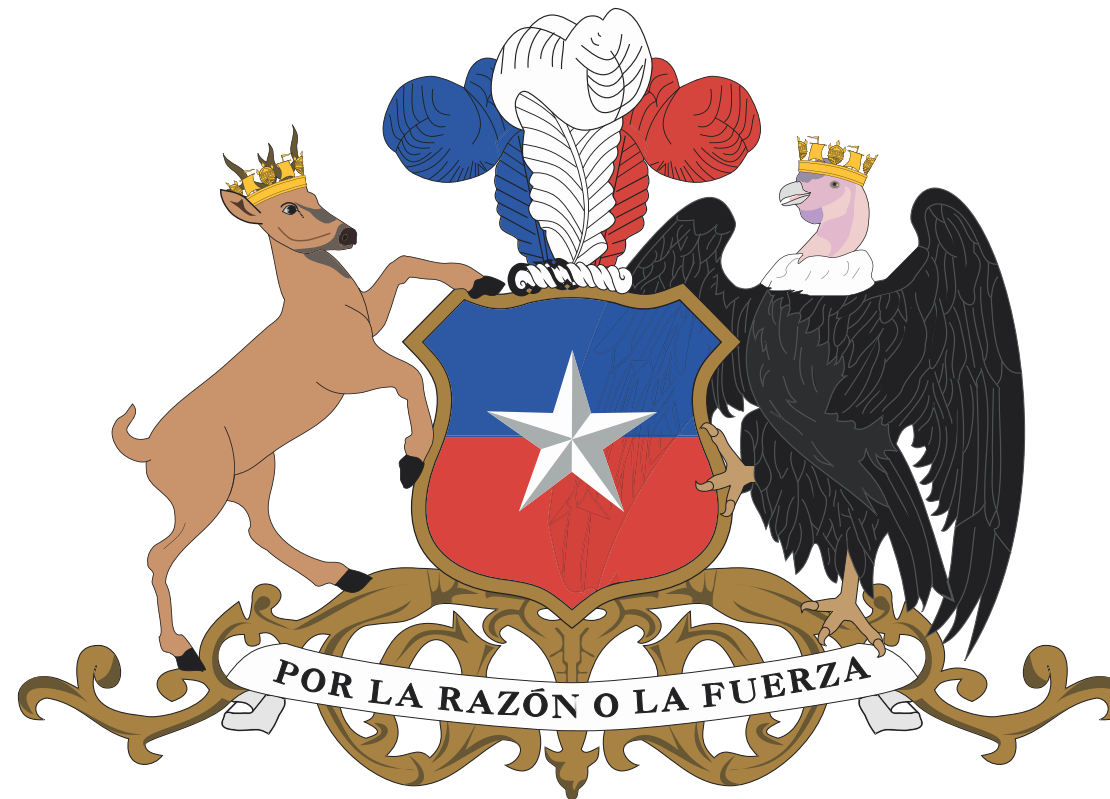
“Until this current constitutional process, the legal framework has faced very few changes in the past 40 years. What has changed is environmental legislation – the threshold is significantly stricter today. Communities have become much more involved, and their perception and reception of mining projects has changed a lot. Authorities, NGOs, and communities are much more critical and are constantly monitoring projects and the behavior of mining companies and contractors. Mining has a reputation of being the ‘big bad wolf’, and therefore building confidence today is more complex. The care and respect of the environment, as well as the development of close and trusting relationships with stakeholders, have become fundamental for mining projects.

Chilean society, similarly to the global tendency, is much more concerned about the environment these days. At the same time, the mining industry has neglected to adequately communicate the enormous contribution it makes to the development of Chile. A combination of these elements has resulted in the negative aspects of the mining industry being highlighted and positive aspects being ignored, and the social acceptance of mining has decreased.”

- María Paz Pulgar, Counsel – Natural Resources, Philippi Prietocarrizosa Ferrero DU & Uría (PPU Legal)

“I believe that striking a balance between attracting sufficient investment for growth and creating more local benefits for Chilean communities come hand in hand – with greater growth, including that fueled by investments, we will be able to give back more to our communities. At the moment in Chile, we are experiencing change with a new government and the ongoing process to write a new constitution. In both cases, we are seeing an emphasis on a more progressive social agenda and potentially higher taxes for the mining industry. I think that mining, and business more broadly, can play a significant part in this new social pact to create a balance that allows businesses to continue to grow and invest in the country, which, in turn, allows them to return more benefits to the communities.”

- Iván Arriagada, CEO, Antofagasta plc





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