ARIZONA Mining

A Supplement to *Engineering & Mining Journal (E&MJ)*

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Freeport Brings Lone Star Online — Copper country's newest mine starts on time and under budget

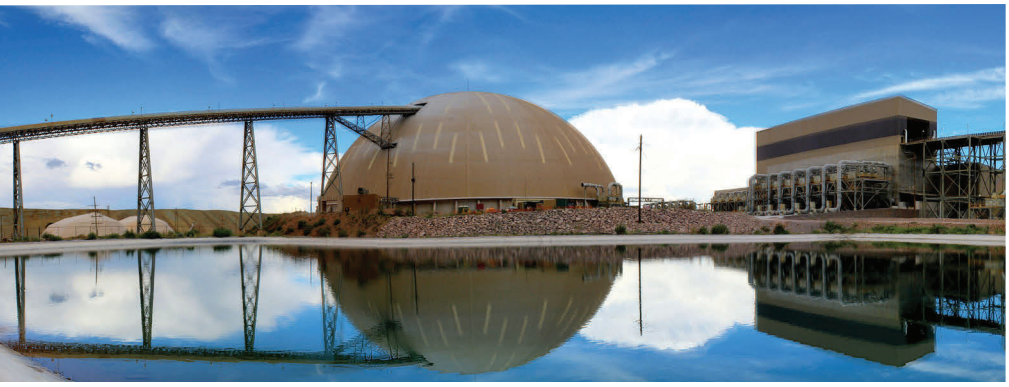
Pinto Valley Finds Ways to Improve Recovery Rates

Northern Vertex Reports Record Gold Production









A Message From Arizona Mining and Industry Get Our Support – AMIGOS

Brett Tanner, Chairman

Sydney Hay, President

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Pinto Valley's Optimization Program Pays Dividends

Continuing to invest during a period of uncertainty, the operation reaps rewards with safety and productivity records

By Steve Fiscor, Editor-in-Chief, *Engineering & Mining Journal* (*E&MJ*)

Vancouver-based Capstone Mining operates the Pinto Valley mine in the historic Globe-Miami mining district of Arizona. It's the only mine currently operating in the district and it has produced more than 4 billion lb of copper since its inception in 1975. After acquiring Pinto Valley from BHP Billiton in October 2013, Capstone has invested steadily to improve its operation, a practice that continues today with the PV3 Optimization initiative.

The PV3 Optimization focuses on a series of low-capital, quick payback projects to de-bottleneck operational performance. The objective was to improve copper production by 10% and lower costs by 10% by 2021. Not only are they going to exceed this goal, they will have done it during the COVID-19 pandemic. A period that has been exceptionally difficult for all business, including copper mining in Arizona.

"The whole organization kept with the investment plan for the mine, knowing that to be competitive over the long haul we needed to complete our optimization plans," said Jerrold Annett, vice president, strategy and capital markets, Capstone Mining. "This pandemic reminded us that, at a moment's notice, the price of copper can drop, so we need to invest in the mine and various technologies that allow us to be more efficient."

In addition to improving blasting, loading and haulage, along with some mill upgrades, Capstone has also embraced some novel technologies to improve recovery and they are paying off as well. One of those is the patented catalytic technology from Jetti Resources that has allowed them to jumpstart historic dump leach sites and essentially recover more copper from waste. They are also pilot testing new coarse particle flotation technology that could boost overall copper recovery by as much as 6%. Processing coarse particles has the potential to lower grinding costs, water usage and energy consumption, while increasing the stability of the tailings storage facility.

When 2020 began, no one expected COVID-19 or that copper prices would briefly dip below $2/lb in March. And from that low point, no one thought copper would be trading at more than $3.50/lb by the end of 2020, but all of these events happened in one year.

"Dealing with this pandemic and all of the related distractions, this mine has delivered at or better than what was planned for 2020," Annett said. "That's incredible and makes you wonder how could this happen in such a difficult environment? It just speaks volumes about the quality of the people we have. We're really proud of what they have accomplished."

Better fragmentation at Pinto Valley is improving downstream processes.

Staying the Course

When other miners were spooked by dark clouds on the horizon in the form of a COVID-19 pandemic and low copper prices, Capstone decided to stay the course. It didn't deviate from its plan to invest in its assets and continuous improvement.

"We cut as much discretional spending as we could," said Mike Wickersham, general manager for Capstone Mining's Pinto Valley. "We kept moving forward with our optimization program, which included installing crushers and screens, and upgrading ball mill shells."

"COVID-19 began to disrupt logistics in March when a ball mill shell, some screens and crushers parts that we were expecting were delayed," Wickersham said. "These were key to the PV3 Optimization and subsequently delayed a planned installation for April until July. Additionally, some of the machines that we intended to refurbish caused some unplanned downtime issues in May and June. But, we got through all of that and managed it, and what has been so impressive is the way the people stepped up to keep the operations running and they did it while keeping health and safety top of mind."

"Sadly, due to the virus, more than two dozen people who were close to our small Pinto Valley team perished, including family, friends and neighbors," Wickersham said. "It's taken an emotional toll. Overall, it's been difficult, especially when the kids could not attend school or when employees were quarantined, but we have managed through it."

"Thank goodness we didn't slow down or stop our operations," he said. "We had to deal with COVID-19 and all of the negative consequences, but we're in a much better position now, especially considering the recent improvement in copper prices."

Finding the Right Mix

Wickersham explained the PV3 Optimization strategy simply as improving the three R's: the run time (hours), the rate of operations (measured in tons per hour), and recovery.

"When this PV3 Optimization work is done, we are going to improve the run time and improve the rate of production, especially with the ball mills, which are the bottleneck for major rate increases," Wickersham said. "We're also improving the recovery of copper in the float plant and from our leaching SX-EW [solvent extraction-electrowinning] operations. Everything we are doing is geared toward making step-change improvements in those three characteristics of performance."

Capstone is also using geometallurgy to try to connect the characteristics of the ore in the block model, such as grade, hardness and mineral characterization, with how the ore will behave when it passes through the ball mills to maximize its production profile. The exercise has proved to be surprisingly complex, Wickersham explained.

"The more we get into it, the more we realize all of the parameters that affect operational performance such as geology, mineralogy, blasting, the particle size distribution resulting from each crushing stage, ball mill liner variables (the design and age), cyclone pressures and slurry density," he said. "It's a complicated subject and we're in the middle of really trying to understand that in greater detail, so that we can take a block of ore from the mine plan and make an accurate prediction for what we can get for rate and recovery in the ball mills and float plant. If we get it right, we can decide on future plans for creating value by modifying throughput."

"Pinto Valley's ore body is fairly uniform with 94% granite and 95% of the copper mineralization occurs as chalcopyrite," Wickersham said. "Even with this consistent mineralogy, it isn't as simple as you would think, but this exercise has greatly boosted our understanding of how we can optimize our operation."

Processing Improvements

Jetti Resources approached Capstone Mining about three years ago because Pinto Valley was an ideal candidate for its proprietary process that uses a catalyst to improve leaching kinetics. Pinto Valley has an SX-EW plant that was built in the 1980s to recover copper from low-grade stockpiled ores that was below the cut-off grade for the mill. The previous mine owners recovered what they could through a dump-leaching process over the years, but leaching copper from chalcopyrite can be difficult.

"You're lucky if you can get recoveries greater than 30% and it takes a considerable amount of time, as much as seven to 10 years to accomplish it," Wickersham said. "The SX-EW plant was running at 10% to 15% of capacity. The thought at the time was that it had run its course and we were considering a shutdown due to the economics. Jetti Resources explained that with this catalytic technology, for very little risk on our part, they could revive the leach kinetics of the historic dump. We tried it for about a year and we saw a large spike in copper recovery."

Overall copper production levels have increased as a direct result of implementing the Jetti Resources process. "We were so convinced that this was going to work that we announced it publicly in July 2020," Wickersham said. "We are now adding more mineralized waste to the dump leach area and we intend to recover 350 million lb of copper over the remaining 19-year mine life. That is 350 million lb that was not in the mine plan and at a cost of less than $2/lb, so it is truly copper recovered from waste. It's a big win for the mine."

The process itself also represents sustainable environmental improvements. Running lower grade ores through the mill requires more water, reagents and energy. Implementing this process required no major capital expense, Annett said. "Jetti erected a building to introduce the cata-

A ball mill shell is replaced at the Pinto Valley plant.

Umut Erol, metallurgy, lab and process control superintendent for Pinto Valley, is pilot testing the Eriez HyroFloat technology.

lyst to our raffinate, and no changes to our existing SX-EW plant are necessary," he said. "Chalcopyrite does not leach well, it is a slow process of many years and ultimate recoveries are traditionally low. The reason is because after extended periods of leaching, a passivation layer forms on the chalcopyrite, which protects it from the bioleach process. The Jetti catalyst breaks down this passivation layer and prevents it from forming again thereby allowing for copper extraction to take place unimpeded."

Plans for Phase 2 of the PV3 Optimization Plan are under way for three projects to be completed in 2021: the CV04 conveyor upgrades, some tailings thickener upgrades and some cyclone cluster upgrades for the ball mills. "There is also one other big piece of work under way in a pilot phase in the flotation plant, the Eriez HydroFloat technology," Wickersham said. "This process was lab tested about four or five months ago and it's showing very promising results."

Pinto Valley's ball mills produce a fairly coarse feed for the float plant, which results in significant copper losses because some particles are too large and heavy to float in our conventional cells. The Eriez HydroFloat technology is particularly adapted to clawing back those copper losses. "In Pinto Valley's case, that could amount to an additional 6% of copper recovery," Wickersham said. "That's huge! After we have invested all of this time and money to drill, blast, load, haul, crush, crush, crush and mill… and now to possibly get an additional 6 points — that is just tremendous. It looks like it's doing at least that in the pilot testing phase that began in December 2020."

This is also in line with Capstone's strategy for reducing power costs per ton, Annett explained. "If you can crush to a coarser consistency, that consumes less power," Annett said. "It also improves our water usage per metric ton of ore. Obviously, the main thrust of this exercise is to recover more copper and the difference between 84% and 90% recovery is an extra 10 million lb/y of copper for at least 19 more years."

Referring to the Pinto Valley mill, Annett offered a restomod analogy: a '67 Mustang Fastback shell with new technology under the hood. "Pinto Valley's mill is a vintage early-1970s operation with new technology platforms throughout, which is steadily improving its performance," Annett said. "We didn't tear down an old mill and build a new one from scratch. We are looking to modern day performance from our 50-year-old operation. That's an efficient use of capital."

Handling Material More Effectively

Pinto Valley's process improvements are not limited to the plant. The company has been testing teleremote D10 dozers to work the stockpiles. The mine has two areas with stockpiles: the coarse stockpile generated by the primary crusher and a fine ore stockpile that holds the feed for the ball mills. "On both of these piles, we have to push material around because it doesn't naturally flow into the feeders," Wickersham said. "Those feeders are located below the bottom of the stockpiles and they pose an engulfment hazard. It's a potential source of fatalities in the mining business. We wanted to find a way to use those dozers to manage the piles without an operator in the cab."

In July, Capstone purchased a Cat 994K wheel loader and they are using it to load run-of-mine ore and waste into 180- and 240-ton haul trucks. It's reaching the same productivity levels as the hydraulic excavators and is burning 20 to 30 gallons per hour less diesel, Wickersham explained. "That reduces the diesel burn by nearly 250,000 gallons per year, which equates to a reduction of 4 million lb of CO_2 entering the atmosphere," he said. "We have lower operating costs on a machine that has greater mobility. It's been a fantastic investment." Capstone was so excited about the machine's performance that they decided to buy a second one.

Breaking records is a great source of pride for Wickersham, especially when they are related to safety and production. "When you're producing pounds of copper or tons of ore safely at higher rates than anyone has ever done, that's always exciting," Wickersham said.

Compared to 2017, Pinto Valley's recordable injury rates are down 90% — that includes a COVID-19 year. During December 2020, they set a shift and daily record for tonnage through the ball mills and they did it with minimal crews.

"These results are absolutely outstanding," Wickersham said. "The mine tripled their ability to generate fines with better fragmentation, which increases the capacity of and reduces the maintenance cost for the downstream operation of the crushers and ball mills."

What really motivates Wickersham is the operation's ability to sustain these changes. "For a lower ore grade operation like Pinto Valley, we have to keep pushing those unit costs down," Wickersham said. "If we can break records and sustain these levels of capacity and productivity, we will weather any commodity cycle that comes our way."

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Freeport-McMoRan's Operations Recover

The company brings the Lone Star project online and relies on its strengths to maintain year-on-year copper sales from its North American ops despite the COVID-19 disruption

By Steve Fiscor, Editor-in-Chief, *Engineering & Mining Journal* (*E&MJ*)

Last year, Freeport-McMoRan commissions the Lone Star operation.

Freeport-McMoRan operates seven open-pit copper mines — the Morenci, Bagdad, Safford, Sierrita and Miami operations in Arizona, and the Chino and Tyrone operations in New Mexico. The company also recently brought the Lone Star project online. Using the established infrastructure at Safford, it is recovering copper from leachable ores at Lone Star and the project is expected to eventually produce 200 million lb/per year (lb/y) of copper with the potential for future expansion options. Freeport also has considerable undeveloped copper reserves in Arizona.

In 2019, Freeport sold 1.4 billion lb of copper from its North America operations. Morenci is the company's leading producer (730 million lb/y) followed by Bagdad (218 million lb/y), Chino (175 million lb/y), Sierrita (160 million lb/y) and Safford (110 million lb/y). Production in 2019 was up across most of the operations except Safford, which received a boost in 2020 from the Lone Star project. The company was hoping to grow copper sales from its North American ops to 1.6 million lb in 2020.

Last year, however, did not play out as many businesses expected. Freeport was on a roll during Q1 2020 benefiting from a humming global economy, and then the COVID-19 pandemic upended its plans. In addition to disrupting day-to-day business for the company, the pandemic clouded the markets with uncertainty and copper prices dropped below $2/lb during March. Facing many difficult decisions, Freeport decided to pivot. They moved to a more austere operating plan in April 2020. Discretionary spending was cut, expansion plans were tabled, some employees were laid off and some executives took a haircut. A minor outbreak at the Chino mine forced them to idle that operation.

In August amid this tumult, Josh Olmsted was promoted to lead Freeport's operations throughout the Americas. Spending considerable time with many operations in both North and South America, he and his team began to chart a path to get production and copper sales back on track while simultaneously dealing

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An overland conveyor delivers copper bearing ore to the leach pad.

with the issues that COVID-19 presented. They relied on technology that allowed people at the Phoenix headquarters to work remotely and communicate with field operations. They also used some of the tools they had developed during the company's Innovation Initiatives and agile thinking exercises.

The Lone Star project was completed on time and under budget and is now contributing to copper sales, and Freeport is now in the process of developing a plan to restart Chino.

By the end of Q3 2020, Freeport's copper sales from its North American operations had reached 1.1 billion lb, a little more than the same period in 2019, despite the lower mining rates associated with the revised operating plans and partly offset by the new production from Lone Star. Freeport is now estimating that its 2020 North American copper sales will be approximately 1.4 billion lb, very much in line with 2019. Considering all that happened in 2020, that's an amazing outcome.

The Lone Star Project

The Lone Star copper project is located near the Safford operation in eastern Arizona. The initial work to develop the project began in 2018. It delivered saleable copper during Q3 2020, and it's expected to have a 20-year mine life with the potential for future expansion. Total capital expense for the initial project, including mine equipment and preproduction stripping, amounted to $850 million. Lone Star makes use of the existing Safford infrastructure, which helped Freeport minimize the capital expenses. As it mines the oxide cap, it exposes a significant sulphide resource, and the company plans to incorporate that into future development plans.

"We have a lot of super exciting things happening here, and I'm looking forward to writing this next chapter for Freeport-McMoRan," said Olmsted, president and COO-Americas for Freeport-McMoRan. "2020 certainly has been a challenge, but the Lone Star project has been a real bright spot for us. It has come to fruition with respect to project completion, and it's generating copper and cash flow. It represents the culmination of a lot of hard work over the years, from getting the mine stripped to delivering ore to the crusher and then the leach pad. All of that is now starting to pay off. The project came online on time and under budget, and that's saying something in this day and age."

The Safford operations, which includes the Dos Pobres and San Juan ore bodies, built its facility around those two deposits, Olmsted explained. "As we developed Lone Star, one of the great things about the project is that we were able to leverage a lot of the existing facilities that were constructed in the original project, which reduced the capital burden when compared with other similar projects," Olmsted said. "It's also in a district where we have a high level of confidence that it will continue to grow."

Freeport knows the mineralogy in this district well. "We know how to best take advantage of productivity, efficiency and costs," Olmsted said. "Beyond the low capital burden, the timing of the project fit well with the sequencing of mine plans. While it's a lower grade deposit, that facility was built around heap leach."

Learning to Adapt

A year ago, Freeport was discussing America's Concentrator, a concept that combined digital technology, data analytics and artificial intelligence (AI) as well as the company's workforce. The object, Olmsted explained, was to think about how to build a modern concentrator without actually building it and applying that technology to existing operations instead. "Then COVID-19 arrives in March 2020. The world changed, and we had to pivot," Olmsted said. "But a lot of what we learned as a part of that process has allowed us to be extremely successful this year."

Freeport continues to use innovation, data analytics and AI technology. Many of these programs started with Bagdad and then expanded to Morenci and Safford. The

Copper Mark

Freeport recently announced its commitment to the Copper Mark, a new, comprehensive assurance framework that demonstrates the industry's responsible production practices and contribution to the U.N.'s Sustainable Development Goals. It is the first and only framework developed specifically for the copper industry and enables each site to demonstrate to customers, investors and other stakeholders their responsible production performance. The company commenced the process for six of its operating sites in September and in December received the mark for its two South America mines, Cerro Verde in Peru and El Abra in Chile, and its Atlantic Copper smelter in Spain. The company has future plans to validate all of its operating sites against the Copper Mark requirements.

Lone Star project is using some of these agile mindset philosophies as well, Olmsted explained. "We haven't used AI at Safford, but we have used this high-performance culture of thinking that has allowed us to debottleneck a lot of operations and apply innovations at all levels of the organization.

"These programs allowed us to see improvements in efficiency and productivity and drive costs down," Olmsted said. "All of these things that we have learned have helped us be more successful during these trying times, and we have a lot more things in the hopper."

Olmsted pointed to the recent recognition from the National Institute for Occupational Safety and Health (NIOSH) in conjunction with the National Mining Association (NMA) on Freeport's use of the Haul Truck Operator's Scorecard, a tool they developed in-house as a way to drive safety through technology. "It creates value from the data that has accumulated over time," Olmsted said. "It's a culmination of data analytics, feedback loops, and OEM data systems, that allow us to provide direct feedback to haul truck operators regarding technique from a productivity and efficiency stand.

Dealing With COVID-19

Looking at Freeport's operations and the changes that were made as a result of all of that happened earlier in 2020, Olmsted explained that the company's response was based on "what we needed to do to protect our employees and our business from COVID-19 as well as the pandemic's impact on the global economy and copper prices. We have worked through two quarters under the new operating plan and the operations have responded.

"In addition to plan execution, they have also managed the protocols to keep employees and suppliers safe from exposure," Olmsted said. "From that perspective, things are

going really well. With the recent uptick in infections, we have had to redouble our efforts. We are now looking at restarting Chino in 2021 under a modified mine plan. We are currently getting organized and preparing for that restart."

As far as Freeport's corporate headquarters in Phoenix, most of the employees (95%) are working remotely. "When you consider that daily we must move 700 people to the top floors of an executive tower, the elevators alone pose a sizable risk for transmission," Olmsted said.

For Olmsted, safety is an absolute No. 1 priority. "If a project, job or task can't be done safely, we are not doing it," he said. "The best way to improve safety is by listening to input from every employee in the organization. Whether it's a job in the field or an administrative process, everyone has ideas on how to do things better. The best solution is one that includes all of those perspectives: safety, business and efficiency.

"Within Freeport, we have a high level of collaboration, involvement and interaction between the mine sites and central support," Olmsted said. "The level of interactive communication is better now than it has ever been, and that bodes well for the future. We're really focused on inclusivity and diversity and that just adds an additional layer of improvement to a great program."

Looking toward the future, Olmsted has set four goals for himself and his team, which include safety performance, plan execution, technology use and inclusion (diversity). "We will operate safely, and we need to execute according to plan to achieve financial success for the company and its employees," Olmsted said. "We're not using technology for technology's sake; we are putting the information in the right person's hands to help them make the best decisions for the organization." Freeport has already kicked off engagement groups across the organization to determine areas for potential improvement, and Olmsted said he expects this program to bear fruit in 2021.

Safford's SX-EW facility recovers copper from the leachate.

Moss Mine Achieves Record Gold Production

Northern Vertex builds a platform for future growth

By Steve Fiscor, Editor-in-Chief, *Engineering & Mining Journal* (*E&MJ*)

Northern Vertex's Moss mine (above) is the largest primary gold and silver mine in Arizona. (Photo: Northern Vertex)

Northern Vertex Mining Corp. owns and operates the Moss mine, currently the largest primary gold and silver mine in Arizona. Founded in 2012, the company has since gained considerable experience across all areas of operations, including mine development, exploration, acquisitions and financing of mining projects. With promising results from its flagship Moss mine, the company intends to consolidate additional gold assets within the western U.S. The company has set its sights on becoming a midtier gold producer.

The Moss mine is an open-pit, heap-leach gold mine. It's the first open-pit mine to operate in the Oatman District in northwest Arizona, which is part of the larger Walker Lane gold trend that extends into northern Nevada along the border with California. Following feasibility studies, a capital raise, permitting and construction, Northern Vertex brought the Moss mine online in late 2017. By February 2018, they were stacking ore on the leach pad and the mine poured its first gold in Q1 2018.

Production quickly ramped up to 5,000 metric tons per day (mt/d) and the Moss mine achieved commercial production in September 2018. At the end of its second year of production (2019), the Moss mine produced about 40,000 ounces (oz) and Northern Vertex is hoping to grow gold production to 55,000 to 65,000 oz in 2020. The mine currently employs 150 people. They are moving 25,000 to 50,000 mt/d, processing 8,000 mt/d of ore and placing it on the leach pad. They operate a Merrill Crowe facility onsite, which allows them to pour gold and silver doré. The doré is shipped to Asahi Refining in Utah.

The third quarter of 2020 was the company's strongest yet. The Moss mine produced a record 14,673 gold equivalent ounces (geo), a nearly 30% quarter-to-quarter increase. Third quarter revenues reached a record $26.8 million with cash costs averaging $954 per ounce (oz). The mine also established a new processing record of 683,706 mt crushed at an average gold grade of 0.69 g/mt during the third quarter of 2020, which yielded a record 13,083 oz of gold and 119,257 oz of silver.

The mine recently completed a powerline project, connecting it to the grid and reducing power costs. The company has started development of the West pit and is also looking at expanding its heap leach pad. Meanwhile, exploration drilling is further delineating its reserve base.

"Having financed and built the Moss mine during a challenging market environment, the Northern Vertex team continues to exceed expectations with numerous production records, including the completion of key capital projects such as the powerline connection and West pit pioneering," CEO Ken Berry said. "Through an ambitious exploration program that is under way, we continue to see significant opportunity to expand the resource through the drill-bit." With the success they saw with the Phase I exploration results, the Northern Vertex Board approved a 32,000-m Phase II drill program and it has already made some important discoveries. So much so, that the next resource update could lead to a revised mine plan. Exploration is now a priority and Northern Vertex believes the Moss mine may someday become a multimillion-oz mine.

Beyond the Moss mine, Northern Vertex announced a merger with Eclipse Gold at the end of 2020. "Our two goals were organic growth with the Moss mine and growth through consolidation of U.S. gold projects," Berry said. "Eclipse has the Hercules gold project, which is also in the Walker Lane gold trend closer to Reno." The transaction was expected to close at the end of January.

Mining and Exploration Activities

With a strip ratio of 2.15, the Moss mine produced more than 700,000 mt of ore during the third quarter of 2020. The proportion of total ore being sourced from the East pit continues to increase as operations transition out of the Center pit, while pioneering in the West pit is nearly completed, Berry explained.

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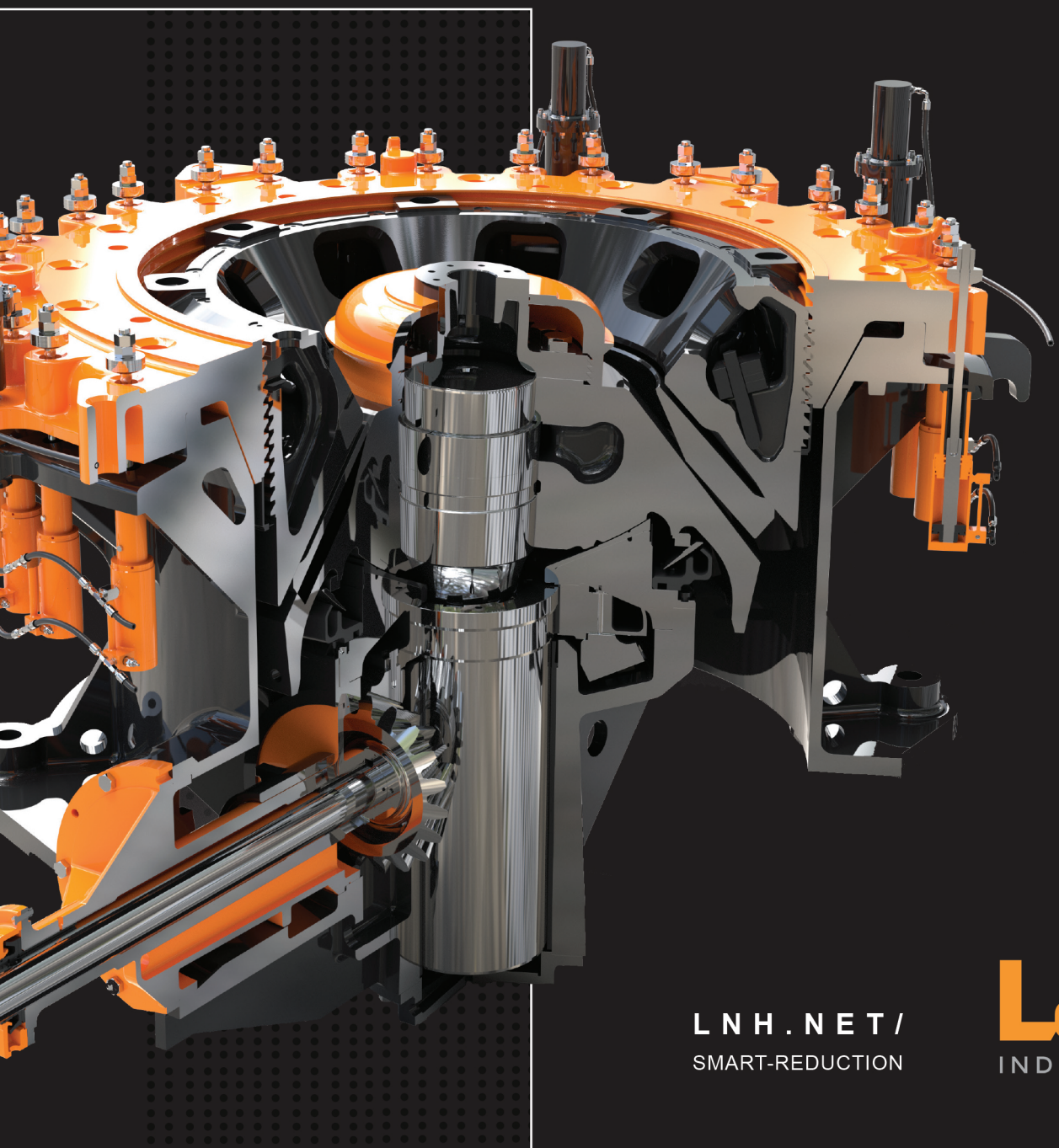

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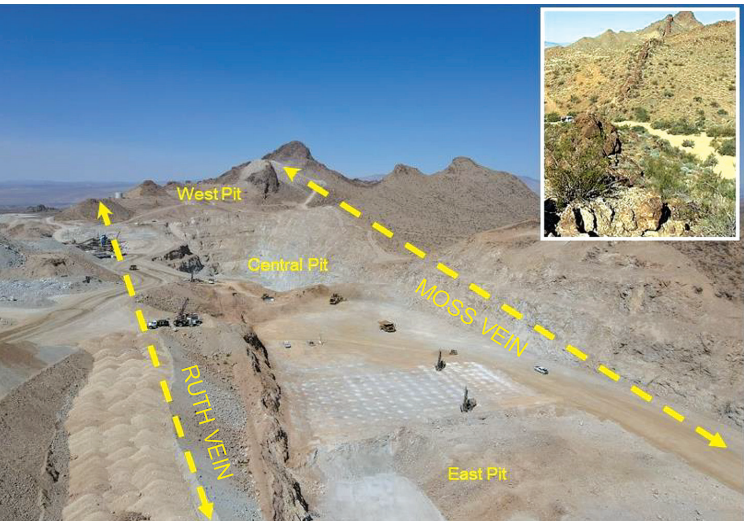


Mining is transitioning from the Center pit to the East pit. Phase II exploration identifies additional prospects with the Ruth vein (inset).

The Moss team advanced several important capital projects during 2020. They completed the construction of a 6.9-mile power line early (September 9). That project connected the Moss mine to the Mohave Power grid and eliminated eight diesel-gensets, reducing power costs from $0.31 per kilowatt hour (kwh) to $0.08/kwh.

"The completion of the powerline and successful connection to the grid further reduces our operating costs, improves reliability, and is a demonstration of Northern Vertex's commitment to sustainability by reducing our carbon footprint," Berry said.

In addition to the direct savings on power costs, which are estimated at $2 million per year, and the environmental benefits, the Moss mine will also save $15 to $20 million that would be spent operating and maintaining those diesel gensets over the life of the mine. Altogether, the powerline project is expected to reduce the Moss mine's all-in sustaining costs by $50/oz.

The Moss mine also constructed and commissioned an Intermediate Leach System, which accelerates gold recoveries from the heap leach pad. A second leach pad was commissioned in February 2020 and the prefeasibility engineering for a third leach pad is under way. Northern Vertex is currently studying the impact of increasing the crush size from 1/4-in. to 3/8-in., which could increase throughput rates for the crushers and reduce costs by as much as 30%. It could also affect gold recovery. Berry said they should know the results of that test work soon.

During May, Northern Vertex embarked on its ambitious Phase II exploration drilling program. So far, the drilling campaign has discovered wide-spread mineralization and high-grade intercepts in the Ruth vein, which also intersects the Moss vein.

Three drill rigs, one core and two reverse circulation (RC) are currently turning on the Phase II program. During December, Northern Vertex reported results from 37 new RC drill holes from the Ruth vein area, which hosts multiple high-grade zones within larger zones of typical Moss mine bulk-tonnage grade mineralization.

"Drilling at the Ruth vein, which runs parallel to our Moss mine, continues to encounter encouraging drill intercepts," Berry said. "The Ruth vein is located just 160 m off the southern edge of our open-pit mine and dips north toward the Moss vein, which dips to the south, with the two veins intersecting at a contact zone approximately 225 m below surface. This Ruth/Moss Contact Zone is a prime geological drill target for our ongoing resource expansion program." The exploration drilling program will transition to target the intersection of those two veins in the coming months.

Berry is optimistic that they will see a significant increase in resources for the operation. "This could take the mine from a small 50,000-oz/y operation to 100,000 oz/y or more," Berry said. In March 2020, Northern Vertex reported total measured and indicated mineral resources of 360,000 oz of gold and 4.5 million oz of silver within 20.6 million tons at an average grade of 0.0175 oz/ton gold and 0.2171 oz/ton silver.

Operations at the Moss mine continued uninterrupted throughout 2020. Northern Vertex said it continues to meet or exceed the recommendations and guidelines of public health authorities at the state and federal level at its operations in Arizona and its headquarters in Vancouver, Canada. The Moss mine set numerous production records during 2020. The first was announced in July when the operation reported record monthly production of 4,713 geo (4,218 gold oz and 37,171 silver oz).

Pioneering of the West pit started in June, with first production coming online soon. Eventually the East, Center and West pits will be unified to optimize mining operations, and to drive down costs.

Northern Vertex is building a platform for growth and Berry foresees further consolidation among western U.S. gold projects. The Moss mine is hitting its stride as production continues to ramp up. Despite issues related to the COVID-19 pandemic, 2020 was an exceptional year for Northern Vertex and this year is shaping up to be even better, Berry said.

Florence Copper Receives Aquifer Protection Permit

Taseko's Phase 1 Production Test Facility will demonstrate to local residents and regulatory agencies such as the EPA and Arizona DEQ that in-situ copper recovery is a safe process.

Taseko Mines Ltd. reported that the Arizona Department of Environmental Quality (DEQ) has granted its Florence Copper project an Aquifer Protection Permit (APP). "This is a key milestone in the advancement of the company's next operating asset," Taseko CEO and Director Russell Hallbauer said. "By issuing this permit, the Arizona DEQ has endorsed the environmental integrity of our project and is confident that the commercial operation will meet all state environmental laws and regulations. The U.S. Environmental Protection Agency (EPA) continues to advance their permitting process and our expectation is that the Underground Injection Control Permit will be issued in early 2021. With construction anticipated to commence in 2021, the timing could not be better with copper being highlighted as the metal of the future as the world aggressively transitions to a green economy."

Florence Copper is proposing to build and operate an in-situ copper recovery (ISCR) facility in Florence, Arizona. This process occurs 400 to 1200 feet beneath the surface, far beneath the drinking water aquifer. The in-situ process uses a mild mixture of 99.5% water and 0.5% sulfuric acid that slowly dissolves copper in the bedrock. This diluted solution, which is the same acidic strength as common household vinegar, is pumped under low pressure through injection wells to dissolve the copper within the copper oxide zone. A copper-rich solution is pumped to the surface through recovery wells for processing into pure copper-cathode sheets.

"When in production, Florence Copper will produce 85 million lb of copper annually at $1.13/lb C1 cash costs over its 20-year mine life," said Taseko President Stuart McDonald said. "Based on our latest technical report, and supported by nearly two years of successful operation of the test facility, the project has an after-tax NPV (8%) of $680 million at a copper price of $3/lb. At today's copper price, the NPV rises dramatically to $920 million, which is roughly three times our current market capitalization. We have derisked the project significantly since its acquisition in 2014 and believe we are on the cusp of having one of the best low-cost, fully permitted and financed copper projects in the world."

"This state-of-the-art copper production facility will have an environmental footprint smaller than any conventional open-pit or underground mining operation of its size, with water consumption 14 times lower, carbon emissions six times lower and energy consumption three times lower," Hallbauer said. "These attributes make Florence Copper an exceptionally green project, which will supply the U.S. domestic market and offset current copper imports."

Construction of Taseko's $25 million Phase 1 Production Test Facility (PTF) is almost complete. The PTF

Florence Copper's SX-EW plant recovers copper from the Phase 1 PTF.

is a small-scale test facility with 24 wells, including four injection wells, nine recovery wells and 15 groundwater monitoring-related wells. This pilot test has demonstrated to local residents and regulatory agencies such as the EPA and Arizona DEQ that ISCR is a safe and proved process. During the PTF period, Florence Copper has demonstrated and enhanced the best water management practices employed at the site to maximize efficient water use and optimize new water treatment technologies.

This won't, however, be the first ISCR facility on this property. The EPA and Arizona DEQ approved a similar test project that operated successfully in the late 1990s. Florence Copper's PTF has further tested and refined the in-situ method of extracting copper underground and has demonstrated to regulators and the community that this process can be done responsibly and effectively while protecting water quality at all times.

The next step is full commercial production, which is expected to last 25 years. Over the full commercial life of the Florence Copper project, it is projected to start up at an annual production rate of 55 million lb/y of copper and then reach an average of 85 million lb/y until the 20th year. The remaining five years will be dedicated to clean closure of the facility in full compliance with applicable federal and state laws.

Ray Land Exchange: A Win-win for Miners and Outdoor Recreation

At the Yavapai County Courthouse during May 2020, Secretary of the Interior David L. Bernhardt was joined by Congressman Paul Gosar, Bureau of Land Management (BLM) Arizona State Director Ray Suazo and other public and private representatives to announce the transfer of lands between the BLM and ASARCO through the Ray Land Exchange. This final step allows for the expansion of hunting and recreation access, responsible mineral development and significant benefits for endangered species, riparian habitat and established wilderness areas in Pinal, Gila, and Mohave counties.

Department of the Interior Secretary David Bernhardt, Rep. Paul Gosar and BLM State Director Raymond Suazo meet with representatives from ASARCO.

"President Trump knows that public lands must be managed in a way that provide opportunities for communities to thrive," Secretary Bernhardt said. "This action allows for the hundreds of mining jobs to continue to produce American-made minerals — reducing our dependence on for-

eign producers — while also enhancing recreational and hunting access on public lands in the West."

"The BLM is pleased to complete the Ray Land Exchange," BLM Arizona State Director Ray Suazo said. "This land exchange balances the public need for hunting and recreation access, the mining company's need to continue responsible mineral development and Arizona's need for continued economic viability."

"This administrative land exchange, which began 26 years ago, is a prime example of an equitable exchange that provides many benefits to the public," ASARCO Vice President and CFO Oscar Gonzalez Barron said. He thanked President Trump, Secretary Bernhardt, his staff and the BLM for all the hard work that was required to complete this exchange.

The Ray Land Exchange received strong support from elected officials and local administrators due to the potential for job creation and economic benefits. Sportsmen, recreational users and ranchers will also yield significant benefits, including increased access, from the lands conveyed to the United States by ASARCO. The majority of input received during the comment period strongly supported this land exchange.

The BLM issued two patents transferring 9,339 acres of public land adjacent to ASARCO's Ray Mine Complex and Copper Butte properties for mine expansion.

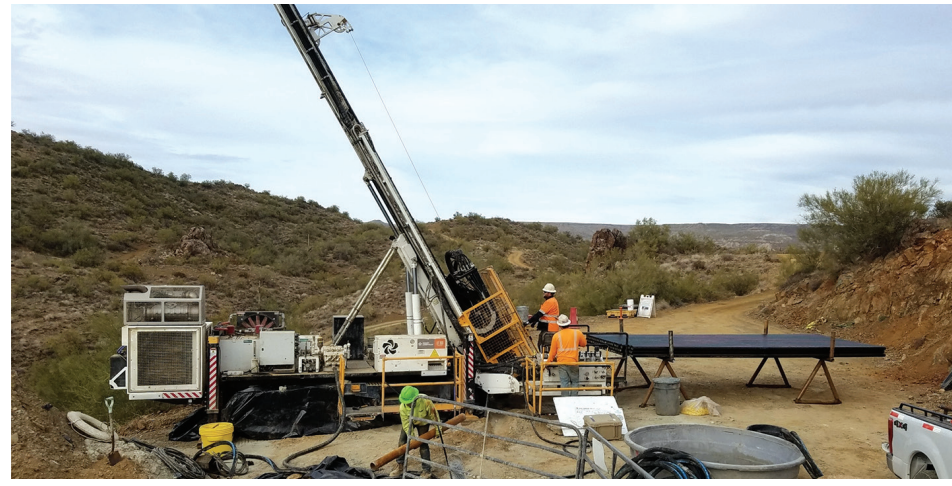
In exchange, the BLM acquired 7,298 acres of ASARCO-owned land in Pinal and Mohave counties through a general land deed, consolidating checkerboard land ownership in those areas, allowing better management of wildlife migration corridors, and improving access to existing public lands for hunting and other family recreation.

Federal law requires that the lands exchanged be equal in value, with no more than a 25% cash equalization payment included. In addition, ASARCO spent more than $15 million to finalize the land exchange, $12 million of which was directed to the BLM and BLM required third-party contractors.

Ultimately, it took 26 years to complete the Ray Land Exchange. During this time, frivolous litigation, and a 10-year National Environmental Policy Act (NEPA) process unnecessarily delayed hundreds of jobs and a minor expansion of an existing mine from taking place, Bernhardt explained.

Arizona Metals Begins Phase 2 Expansion Drilling at Kay Mine

Drilling is under way at Arizona Metals Corp.'s Kay Mine Phase 2 expansion drill program. The 11,000-m Phase 2 program will consist of up to 29 core drill holes, to test for new volcanogenic massive sulphide (VMS) lenses in the steeply dipping deposit.



Arizona Metals contracts with Boart Longyear for exploration drilling on its Kay project.

Permitting is currently under way for these targets and is progressing well. Arizona Metals has contracted with Boart Longyear, who mobilized the first drill to the Kay mine.

"We believe the Phase 2 program has the potential to significantly expand the scope and scale of the Kay project, well beyond the historic estimate," Arizona Metals CEO Marc Pais said. "Our successful Phase 1 drill program greatly increased our confidence in the model. Drilling encountered massive sulphides in 19 of 20 holes. This work has identified a number of high priority drill targets, which we believe have the potential to host additional VMS lenses, as well as wide mineralized hinge zones."

The Kay project in Yavapai County consists of a combination of patented and BLM claims totaling 1,300 acres that are not subject to any royalties. A historic estimate by Exxon Minerals in 1982 reported a "proven and probable reserve of 6.4 million tons (t) at a grade of 2.2% copper, 2.8 g/t gold, 3.03% zinc, and 55 g/t silver. *Editor's note: The historic estimate has not been verified as a current mineral resource.*

In addition to the Kay mine, Arizona metals also owns 100% of the Sugarloaf Peak Property, in La Paz County, which is located on 4,400 acres of BLM claims. Sugarloaf is a heap-leach, open-pit target and has a historic estimate of 100 million t containing 1.5 million ounces gold at a grade of 0.5 g/t.

Resolution Restores Historic Mining Land

Resolution Copper has completed a $75 million restoration and reclamation project of 475 acres of land impacted by close to a century of historic impacts from the Magma copper mine near Superior, Arizona. The company voluntarily committed to accelerate the reclamation work to demonstrate its commitment to cleaning up the historic mining impacts well in advance of any new mine development activities.

"We're proud to deliver this significant piece of environmental remediation work decades earlier than required, to make our community a cleaner and safer place to live and work," Resolution Copper Project Director Andrew Lye said. "Cleaning up the historic Magma copper mine ahead of time demonstrates our commitment to operating safely and responsibly, in a way that brings lasting benefits to the entire community. This work was completed by local contractors and ongoing post-closure monitoring and maintenance activities will continue to provide local jobs as an important part of our business."

In total, the reclamation project has supported more than two dozen local jobs with businesses such as Oddonetto Construction, based in Globe, Arizona. "Resolution Copper has been an important source of business for my firm for more than a de-

Resolution Copper restores 475 acres of land impacted by the Magma copper mine near Superior, Arizona.

cade, and I look forward to continuing to work with the company to grow our business," Oddonetto Construction Owner Mike Oddonetto said.

The Magma Copper Co. ran mining and processing operations between 1910 and 1996, including smelting operations on the site between 1924 until 1971. Since 2005, reclamation work by Resolution Copper has included more than a decade of soil cleanup, placing a cover with soil and vegetation over the historic tailings, restoring and establishing drainage for the conveyance of stormwater, reshaping and vegetating development rock piles, and removing the old concentrator complex and smelter structures. Reclamation and restoration have included shaping landforms to a more natural landform and vegetating with a native seed mix characteristic of the surrounding Sonoran Desert landscape.

Recently, the completed restoration and reclamation was approved by the Arizona Department of Environmental Quality (DEQ). As required, Resolution will continue post-closure monitoring for the next three decades, including groundwater monitoring, surface water monitoring, regular inspection of all facilities and monitoring of the vegetative cover.

Resolution Copper also recently completed a $200 million project to deepen the Magma copper mine Shaft No. 9, originally constructed in 1971. Over the last four years, the shaft has been sunk a further 2,000 ft to more than 6,800 ft below the surface. It connects to the newer Shaft No. 10 in two places, improves ventilation, and increases safety by providing a second exit for workers.

Resolution will now focus on the maintenance of Shaft Nos. 9 and 10 and continuing the underground characterization study to increase ore-body knowledge, as the project continues to progress through a multiyear federal, state and county permitting process. After the permitting process, a detailed feasibility study will be completed. When an investment decision is made, Resolution Copper is expected to take around 10 years to begin production.

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