

ARIZONA

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Mining



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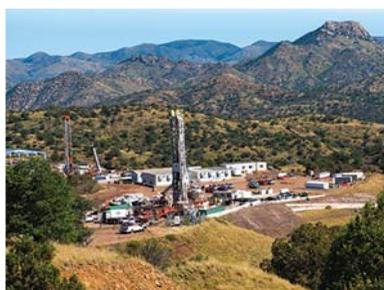
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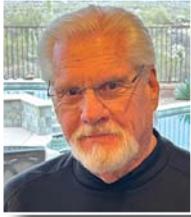
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A Message from Arizona Mining and Industry Get Our Support – AMIGOS



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Sydney Hay, President

It is an exciting time to be in the mining industry. As our nation moves toward an ever-greener economy, mining will be more important than ever before. Green technological innovations need vast amounts of copper, silver, gold, lithium, rare-earth elements, and more. The future of mining is a bright one and an exciting one.

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Freeport Plans to Convert the Bagdad Mine to Autonomous Haulage

In addition to improving safety and efficiency, the change could reduce the mine's idle time by 10,000 hours annually

By Steve Fiscor, Editor-in-Chief

Freeport-McMoRan and Caterpillar recently announced that the two companies are collaborating to convert the mining company's fleet of 33 Cat 793 haul trucks at its Bagdad mine in Arizona to an autonomous haulage system (AHS).

"We look forward to partnering with Caterpillar to become the first U.S. copper mine to implement a fully autonomous haulage system, and we are excited about the numerous benefits it will bring to our Bagdad operation and employees," said Kathleen Quirk, president, Freeport-McMoRan. "The three-year conversion project is expected to improve safety, optimize our fleet, reduce GHG emissions through reduced idle time and position us to capitalize on future technological advancements in electrification."

Cat recently celebrated the 10th anniversary of its MineStar Command for hauling platform, and the company has more than 620 haul trucks operating autonomously around the world. These trucks have hauled more than 6.3 billion metric tons of material and traveled more than 143 million miles without causing any reported injuries.

"We are pleased to collaborate with Freeport as they transition to fully autonomous haulage at Bagdad," said Denise Johnson, group president of Caterpillar Resource Industries. "The Cat 793 haul truck remains Caterpillar's most popular autonomous truck model and is well proven to enhance safety, increase productivity, and reduce idle time across multiple operations, including copper mines. Additionally, Caterpillar continues to

work with Freeport, and other mining companies, to introduce new electrification technologies supporting their sustainability objectives."

Located approximately 100 miles northwest of Phoenix, the Bagdad mine is a porphyry copper deposit containing both sulphide and oxide mineralization. It consists of an 85,000 ton-per-day concentrator that produces copper and molybdenum concentrate and a solvent extraction/electrowinning (SX/EW) plant that produces 9 million lb/y of copper. It is one of the oldest, continuously operating SX/EW plants in the world.

Meeting Sustainability Objectives

Freeport-McMoRan has active partnerships with Cat and Komatsu to advance zero-emissions mining trucks, supporting technologies and infrastructure. In mid-2023, the company decided to transition the haul truck fleet at the Bagdad mine to 100% autonomous over three years.

The first two years of the conversion project will be spent retrofitting the existing haul trucks with autonomous technology, installing new supporting equipment and infrastructure, and training its workforce to safely operate and service the new technology. During the third year, the autonomous trucks are expected to come online.

Manned trucks run 24/7, but often sit idle for, among other things, operator breaks, shift change, fatigue and coaching. Freeport's preliminary estimates indicate that Bagdad will be able to reduce idle time by more than 10,000 hours per year.

Although full electrification of haul trucks on a large scale is still years in the future, autonomous haul



The cycle time for the trucks at Bagdad varies from 30 to 60 minutes from the pit bottom to the crusher or multiple waste dumps. (Photo: Freeport)



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The background image shows a large-scale industrial construction project. A prominent yellow tower crane stands in the center, with its long jib extending across the upper portion of the frame. Below the crane, a complex network of steel structures, walkways, and pipes is visible, indicating the construction of a large facility. The sky is overcast and grey.

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As each haul truck comes into the shop for a rebuild, it will be converted to AHS. (Photo: Freeport)

truck technology is an important step toward electrification. Rather than waiting for electrification technology to be developed and attempting to embrace it all at once, by transitioning Bagdad now, Freeport believes they will be able to learn more about autonomous technology and how to leverage that technology before battery-operated haul trucks are introduced.

The Rationale Behind the Decision

The Bagdad mine has operated manned fleets very efficiently for many years. They had evaluated the use of AHS in the past but didn't believe the economics would work. Today, both Cat and Komatsu have much more experience operating fleets and Freeport reconsidered.

"The efficiency of autonomous fleets historically hasn't kept pace with, or hasn't met the capability of our manned fleets," said Justin Cross, vice president of operational improvement for Freeport-McMoRan. "The economic driver wasn't there at the time and the economics just wouldn't work out. The technology, however, has matured. The Bagdad mine was also dealing with some constraints as far as finding and retaining labor. That, coupled with the possibility of running

battery-powered trucks in the future, brought the decision on AHS forward. The time was right, and we believe AHS will now be economically viable as a deployed haulage solution."

Cross believes the transition will improve efficiency. "We are implementing AHS at a site that is positioned to grow," he said. "Increasing the workforce to support manned haulage is not a viable option, and AHS minimizes that need."

The use of electrically powered haulage, whether it's batteries, overhead trolleys or both, is rather complex. "Power management with these systems will be incredibly important," Cross said. "If you have a 500-ton truck running on empty, the operator has to decide whether to make one more run or recharge. What speed were we supposed to be traveling on that trolley line? Should I go to the shovel and get another load? Do I have enough power to make it to the crusher? AHS solves the problems associated with people making those decisions. If electrically powered haul trucks are our future reality, we knew we needed to get familiar with AHS."

Freeport selected the Bagdad mine, not only because of the workforce challenges, but also because it was a mid-sized mine. "Bagdad has

enough trucks to make this deployment make sense," Cross said. "We thought about smaller mines, like Tyrone and Climax, but the truck fleets are not large enough. For a mine like Morenci, that would be a big leap to try and go from a manned fleet to autonomous at a complex like that."

The mine plans to improve its current mesh network to support data transfer. "This will be dispatch on steroids," Cross said. "Mesh networks are a little more expensive, but highly reliable, and we need 100% coverage all the time."

Bagdad operates one deep pit with a long uphill haul to a crushing installation or multiple waste dumps. The cycle time for the haul trucks varies from 30 to 60 minutes. "Bagdad is the right size for the initial deployment, the technology is mature enough, and we want to learn about AHS," Cross said.

Making the Leap

Komatsu and Cat have a great deal of experience running trucks autonomously, Cross explained, but Bagdad already had a Cat platform in place and the upgrade just made sense. "Bagdad runs a standard fleet of Cat 793 haul trucks," Cross said. "We can readily apply the technology to our existing fleet."

Bagdad has already started to retrofit the trucks, but it is not running any trucks autonomously yet. "We rebuild all of our trucks," Cross said. "As the trucks go to the shop for a rebuild, we install the autonomous-ready packages and then rebuild them. The first autonomous truck will probably be running by the middle of 2025."

Cross said they will integrate the autonomous trucks one at a time with the manned fleet. The fleet will operate mingled until the transition is complete. "We will be looking for the opportunity to make efficiency gains and learn more as we evaluate the conversion process," Cross said.

Obviously, this is a huge change management process, but the people part has been a pretty good story, Cross explained. "We sat down with every-

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one and explained all of the different options that they can pursue. We have already started socializing some of the new jobs and what they would look like. One example would be pit builders. The pit has to be designed so that the trucks know the roads, and where the shovels are located constantly. That's a job. There are a lot of instrument tech jobs, and we have been soliciting interest from folks."

Bagdad has also asked the operators what they would like to do once the mine starts phasing out some of the haulage operator jobs. "We are not going autonomous on our support fleet," Cross said. "Those operators that want to continue to drive a truck can drive water trucks and other small support equipment, like the Cat 777s, etc. Or, if they wanted to go to a different site to continue to drive trucks, Freeport would support that as well."

"We are bringing our people along with us," Cross said. "A career path at Freeport will be available for them with new jobs coming online."

Management will need some retraining as well. "Cat has a lot of expertise, and we have already sent some of our people to Australia and Canada to learn from those opera-

tions," Cross said. "We're working with sites that have already deployed autonomous, and we're working with an OEM who has deployed multiple autonomous fleets. Our Cat dealer, Empire, has been a great partner in helping us move forward."

Measuring Improvement

Both Komatsu and Cat have had a phenomenal decade plus safety record with autonomous haulage, Cross explained, with no lost-time accidents associated with haulage. "AHS uses a lot of safety-related barriers, and the system's default is to essentially shut down before any potential collision or safety-related event," he said. "Whether it's fatigue or just the energy associated with the trucks, one of the more complex things to manage at our operations is safe powered haulage. We perceive a notable improvement in workplace safety as a result of autonomous deployment." When it comes to powered haulage, the Bagdad mine has a respectable safety record, and they plan to maintain or improve that statistic.

Another area where Freeport could anticipate improvement is with haul truck maintenance. The autonomous trucks will run as designed most

of the time. "We are also anticipating the fleet to run more consistently with better road conditions," Cross said.

Bagdad's truck fleet historically has run quite efficiently. "With optimization, we might be able to eliminate a truck or two over time, but the biggest benefit will be the efficiency gain from the manpower side," Cross said. "Productivity and cycle times should improve. We will have no idling for operator breaks. We already combine shift change and refueling. There would be a degree of benefit on shift change, not waiting for the driver, but the trucks still have to be refueled."

Cross said he will consider the transition a success when they see the efficiency gains that they anticipate. Success would also be achieved when Freeport is so confident with the technology that they would consider deploying it at other operations. "As far as how it fits into our future power management solution, we won't know that for a while as it's on a longer timeline," Cross said. "If we can prove that autonomy is equal to or better than the efficiency of our manned fleets, that will be a success on our way to the power management solution."

One source of pride for Cross and Bagdad General Manager Jeff Monteith is that the Bagdad team has realized that this could be a win-win for everyone. "We're not making this transition to eliminate jobs," Cross said. "Haulage operations are very difficult jobs, and the new jobs will be a change for the better. Everyone is a winner in this. Through the deployment of technology, we're creating jobs that are better for people. They will get to learn and apply new skills."

"We're reducing the input costs of running our operations, which extends their lives," Cross said. "Automation can be used to serve business and the workforce. There is a lot of noise about displacement when it comes to AHS. Yes, we're displacing workers, but they are not leaving the mine site. Many will move into upskilled positions."



AHS is being installed now, but the first autonomous truck will not roll out until mid-2025. (Photo: Freeport)

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Elevation Gold Charts a New Course

Efforts to develop a workforce culture while chasing gold veins pays dividends

By Steve Fiscor, Editor-in-Chief

Elevation Gold Mining Corp. operates the Moss mine in Mohave County, Arizona. The company produced 8,380 ounces (oz) of gold and 53,911 oz of silver in Q3 2023, and 7,989 ounces (oz) of gold and 60,706 oz of silver in Q4 2023. Those quarterly figures, which were an improvement over the previous two quarters, only tell half the story.

The Moss mine encountered higher grade ore which fragmented better, leading to record crusher throughput, and some much-needed operational stability. The mine is currently extracting ore from the West Pit and Mordor areas, and they recently completed the 3B Leach Pad, on time and under budget. Through Q3, 2023, cash costs are down \$262/oz for the year versus similar periods last year, reflecting great work by the team at Moss mine.

Mining plans are not the only transitions at the Moss mine. New approaches to management are leading to a cultural shift in the workplace. “We have been working hard to improve the workplace culture and safety at the same time,” said Elevation Gold CEO Tim Swendseid. “We have improved our training programs, and our safety reporting system. We are now offering competitive compensation and have created a more inclusive work environment.” These changes have led to a more loyal workforce that’s operating more safely.

Moss Mine Transitions to the West

Mining in the East Pit is now complete and most of the mining activity is focused on the Mordor area and the West Pit. “We fired the last blast in the East Pit in early December,” Swendseid said. “There is some additional drilling that we hope to do that would allow us to deepen the East Pit. That’s part of a longer-term plan that would require the relocation of the crusher to



An aerial view of the Moss mine looking east shows the West and East Pits and the crushing installation in the center. (Photo: Elevation Gold)

access a rich zone where the Ruth vein intersects the Moss vein. We’re hoping that will be included in the plan for seven to 12 years out, but we need to perform some additional drilling to confirm that ore first.”

The Moss mine is already stacking ore on the new 3B Leach Pad, which was completed in early November. Designed by Newfield’s and constructed by Ledcor, it’s a 1 million ft² pad and it will add 2.5 years of capacity, Swendseid explained. “It will give us production capacity through the end of 2025,” he said. “We like to build them in 2-year increments. We’re already working on the design for the next pad and plan to start construction in late 2025.” Building leach pads is a large capital expenditure, and the company tries to pace itself to spread out those capital costs as part of its cash flow management.

Meanwhile, exploration drilling continues in the Reynolds pit. “We had some very interesting drill results in the Reynolds pit recently,” Swendseid said. “One of the holes turned out to be the most exciting hole ever drilled at the Moss mine. Hole AR23-663R intersected 225.6 meters of mineralization grading 0.56 grams per metric ton (g/mt) of gold and 2.77 g/mt of silver. The grade was well above our operat-

ing cutoff grade of 0.31 g/mt. It looks like we have found an area with the potential to dramatically improve economics in the western side of the pit.”

The new ore zone is within Elevation Gold’s permitted area for mining and leaching. “We performed a small drilling campaign a couple of months ago and we are currently in the middle of another small campaign trying to connect the dots,” Swendseid said. “From the assays that have been reported so far, it looks like we have hit the same ore zone in three drilling fences.”

The miners knew the Moss vein was there and they suspected there could be more gold in the area. “The mine’s exploration geologist at the time decided to drill a hole toward the south, and low and behold, he hit this really decent ore zone,” Swendseid said. “The East Pit is currently our best ore zone as it has a much better grade than the West Pit, and this new mineralized zone may be as good or better than the East Pit.”

Production in the West Pit is currently being supplemented with ore from the Mordor area, which is a little bit west of the West Pit. “The Mordor area is an area that was also under explored,” Swendseid said. “About five years ago, someone put some percussion holes into it, but it was never



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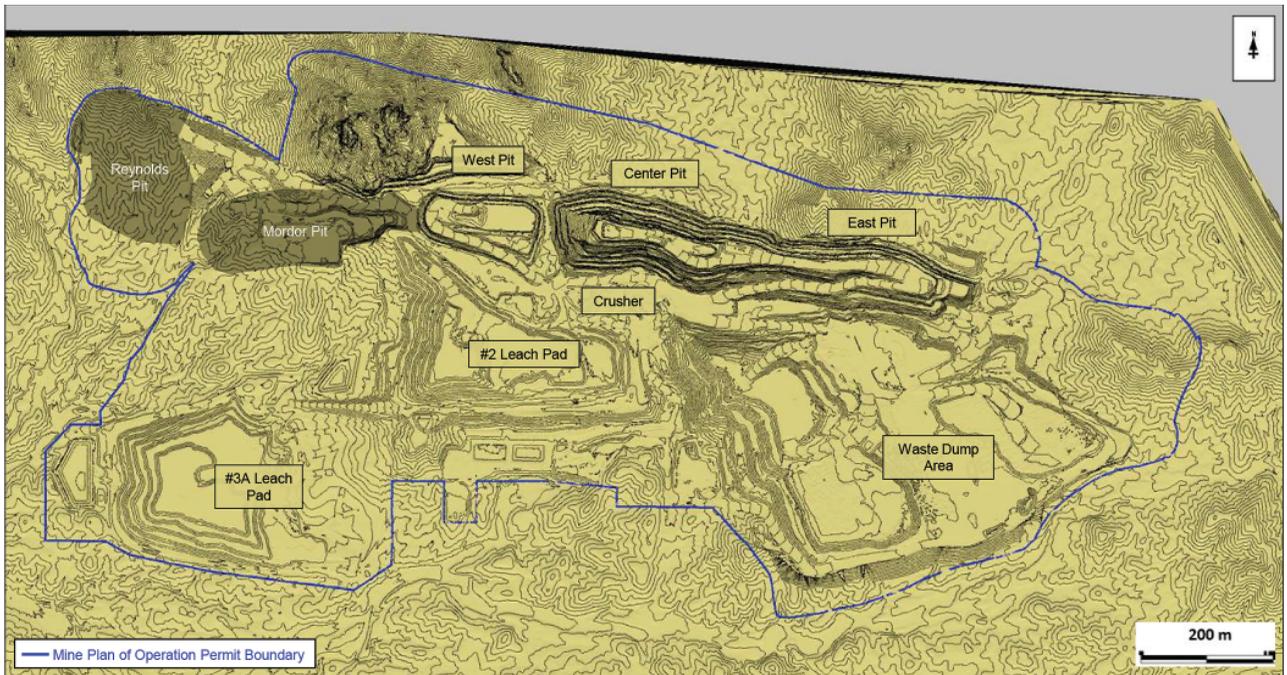
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After encountering hard ore in the East Pit, mining operations have transitioned to the Mordor Pit west of the West Pit. (Source: Elevation Gold)

drilled well enough to be placed into the orebody model. After some additional drilling, we decided to move the production blasthole drills there and started mining the Mordor area. We have since hit some very good ore or what we call a ‘very positive reconciliation’ to what the orebody model predicted.”

The geology in the West Pit had become very hard to the point where it was affecting fragmentation and crushing negatively. The rock in the Mordor area is completely different. It’s easier to blast and crush and has a better grade.

Today, most of the mining at the Moss mine is concentrated in the Mor-

dor area. “We are working off of a mine plan for an area that remains under-drilled, and we can’t get drill holes in it fast enough to fully understand it,” Swendseid said.

Improving the Workplace Culture

Elevation Gold has invested considerable effort in improving the workplace culture at the Moss mine. The company brought Justine De Boom on board as vice president of human resources. In the past, the company had a punitive attitude toward employees, Swendseid explained. “If they had a safety issue or did something that they ought not do,

maybe even because of improper training at the mine itself, they were terminated and the mine suffered from an extreme amount of turnover,” he said.

De Boom identified the issues and has focused her efforts on building an inclusive workplace culture that engages employees. One of the primary objectives was to improve safety by offering more training and allowing people to report safety incidents, especially near misses. “We needed to learn from them,” Swendseid said. “The entire cultural improvement effort has resulted in a workforce that’s much more loyal and our retention rates have improved dramatically. Our turnover rate is still high, but it is way better than what it was.”

The results can also be seen in the mine’s total recordable incident frequency rate for 200,000 man-hours. “We have brought that statistic way down and we are now confident that we are reporting everything properly,” Swendseid said. “At the same time, the number of near-miss incidents reported has increased dramatically. We applaud people who turn in a near miss incident through our Good Catch Program.”

The program identifies the actions or inaction that led to the near miss



The 3B Leach Pad was completed on time and under budget. (Photo: Elevation Gold)

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and asks how it can be prevented in the future. It also rewards employees that participate in the program. “We also now offer production bonuses, and our workforce has become a more inclusive group,” Swendseid said.

Elevation Gold also brought Jim Fowler on board as the general manager of the Moss mine. “He has worked in Arizona for the majority of his career, and he is a solid coach and mentor with a ton of operating experience,” Swendseid said.

The continued focus on safety and employee retention has created a more stable workforce, which has led to consistent operations and will allow us to drive costs down in the future, Swendseid explained. “With our low-grade

ore, keeping costs at a minimum is a company-wide requirement,” he said.

The Moss mine employs 200 including contractors, and the main mining contractor is Ledcor. “The demographics that we pull from for the workforce come from the Bullhead City, Arizona, and Laughlin, Nevada area,” Swendseid said. “The base of employment in that region is hospitality related, people who work in the casinos, hotels, and restaurants. So, they are not mining people per se. We train them and teach them about mining and operating safely and give them the opportunity to secure a long-term career that pays better than the hospitality industry.”

Swendseid said it’s rewarding to see the workforce stabilize. “When

I arrived a couple of years ago, we were coming out of COVID-19 and it was hard to keep people at any of the positions,” Swendseid said. “People would not show up for interviews and Starbucks was paying more than we were. Today, the tables have turned.”

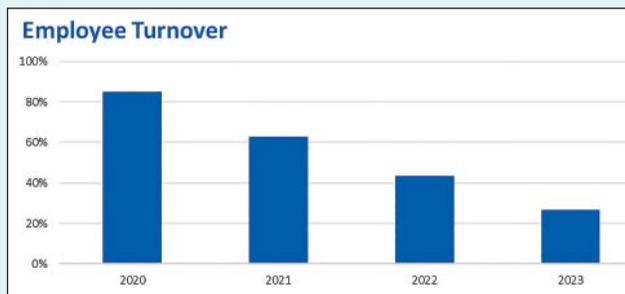
Looking toward the future, Swendseid said his vision is to continue drilling these geologic structures that run from the east to the west and identify enough gold to keep the Moss mine in business for the next 10 to 15 years. They also need to get through a permitting phase to expand their operation. Elevation Gold still has 165 km² of exploration area at the Moss mine and they are still finding targets adjacent to the active mining areas.

The Good Catch Program

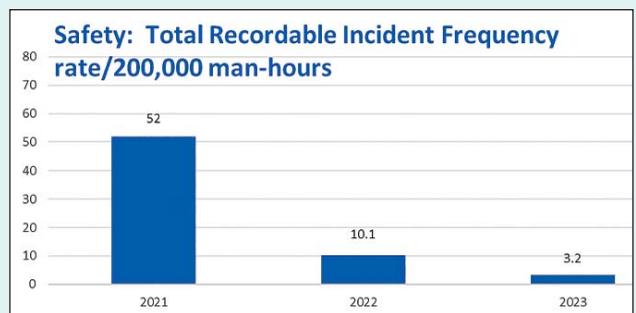
Staff turnover and safety in the workplace are interlinked. Three years ago, the Moss mine had a poor safety record, and it was experiencing high staff turnover. “In an effort to focus on positive behavioral safety programs, we developed the Good Catch Program,” said Justine De Boom, vice president of human resources for Elevation Gold. “Before something becomes a near miss, before it becomes an incident, we get out there and positively identify this issue that has the potential to injure somebody or create a hazard in the workplace. And, we have built that into the production values of the mine site itself.

The punitive mentality toward safety was working against the Moss mine. “As quickly as we could hire people, they were leaving because of this punitive mindset,” De Boom said. “If somebody did something wrong, they were terminated. We needed to develop a culture and we began to change the way we do business. Today, we are hiring people from the local communities, training them and molding them into miners, and it has paid off.

De Boom worked with Moss’s managers to develop training plans. They also implemented regular performance



Elevation’s efforts to improve workplace culture has resulted in a steady decrease in employee turnover. (Source: Elevation Gold)



With a new program in place, the Moss mine’s total recordable incidence frequency rate has declined dramatically. (Source: Elevation Gold)

reviews. “I personally attend every performance review,” De Boom said. “It’s important for me to connect with the employees whilst we get some great feedback.”

The mine now surveys its employees and asks their opinions. “Before we make a change in the workplace, we send out a survey,” De Boom said. “It’s important for employees to be part of the decision-making process. Their opinions mean something. We do a lot of consultative work with our employees. It’s human nature for people to be critical of any workplace. We’re not perfect, but I think when you make them part of that process, they feel that they are valued as an employee.”

De Boom added “we also focus on connecting with all employees by conducting quarterly communication meetings with management to provide an overview of the mine’s performance and listen to employee feedback about how we can better do business. Additionally, a key performance indicator for the Executive Management team is to attend the department line out meetings and interact daily with the safety management of the mine site. Communication has been the key to their success.”

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Pinto Valley Helps Capstone Meet Its Sustainability Goals

Ongoing projects protect and support people, the environment and cultural heritage



The Pinto Valley mine has found ways to conserve water in a water-stressed district. (Photo: Capstone Copper)

Capstone Copper recently published its 2022 Sustainability Report, *Growing Responsibly*. In it, the company, which operates the Pinto Valley mine, located in the west end of the historic Globe-Miami mining district of central Arizona, documents several initiatives that are contributing collectively to improving its sustainability. Pinto Valley contributed through its efforts to, among others, sustaining biodiversity, supporting mental health, and showing respect for cultural heritage.

A little more than a year ago, Lyndsay Potts was named general manager for the Pinto Valley mine. As the mine's first female general manager, she brings a wealth of experience from positions she held in geotechnical services; mine management; health, safety and environment; and community relations. She and her family relocated to Arizona from Australia in November 2022.

In the report she emphasized the importance of local recruitment. "It's about community involvement,"

Potts said. "We want the community to see that we bring revenues, wages and pride. We're not just making donations — we are members of these communities. It's important for our growth plans that we earn the support of our communities. We also need to show we take their concerns seriously, such as their concerns about water conservation."

Potts also discussed one of her goals, meeting the Copper Mark Criteria for Responsible Production, which is more challenging for a legacy site like Pinto Valley. "We are actively working to bring this site up to Copper Mark standards and challenging norms about what can be done with aging infrastructure," she said. "It has people excited."

Pinto Valley recently marked 10 years of continuous operations and they want to extend that trend with sustainable production by operating efficiently and reliably, conserving water and maintaining low turnover.

Energy Efficiency and Water Conservation

Capstone said energy efficiency is a key criterion for upgrading equipment and securing funding for new capital projects on site. For example, Pinto Valley has replaced several pieces of equipment that reached the end of life with newer, more fuel-efficient models. Some of the new equipment uses engines that exceed U.S. EPA Tier 4 regulations and provide up to 20% fuel improvement in efficiency over previous models.

The company also encourages sites to look for efficiency opportunities with energy-intensive infrastructure. In 2022, Pinto Valley completed an efficiency study of its grinding circuit, which is responsible for two thirds of the mill's energy consumption.

All of Capstone's mines operate in water-stressed regions with the potential for water shortages. Arizona has experienced extreme drought conditions over the last several years, leading to increased attention to water use. There are also cumulative impacts on local water resources resulting from different users competing for water in water-stressed areas.

Collaborating for the benefit of all shared interests, Pinto Valley works with and responds to communities and stakeholders who have a shared interest in the health of the Pinto Creek watershed. The mine hosts and facilitates annual meetings with Pinto Creek stakeholders to discuss the mine's water use and the water budget of the watershed. Pinto Valley also works with the U.S. Forest Service and other stakeholders to map and monitor wells, seeps, and springs in the watershed, and funds the monitoring of U.S. Geological Survey stream gauge stations along Pinto Creek.

Pinto Valley also uses alternate tailings deposition methods to reclaim more water from its tailings storage facility (TSF) and it deploys physical and chemical inhibitors to reduce evaporation. Upgrades to the center walls of the tailings thickeners in 2021 resulted in savings of about 3,000 liters per minute due to water recovered from the thickener overflow.

Capstone has Independent Tailings Review Boards (ITRBs) comprised of external third-party technical experts who have not been involved with the design or operation of the TSF. The boards meet periodically to review and provide recommendations to improve Capstone's tailings management. The company regularly reviews closure and post-closure costs and provisions. They engage independent experts to estimate the TSF closure and post-closure costs at each site.

Suppressing Dust in a New Way

Managing dust is a full-time preoccupation for Pinto Valley Operations Superintendent Lyn Jugler. His team works closely with the environmental department to ensure air quality permits are met. They are highly aware of the impact dust can have on nearby towns or people using the major road that passes by the mine. It's also a workplace concern. As Jugler puts it, "Nobody wants to breathe dust all the time."

Water trucks operate continuously to manage dust on the roads in and around the pit. However, in the heat of summer, the benefit of watering only lasts about 15 minutes. That's why Pinto Valley was keen to try a new product made of magnesium chloride that can be mixed 1:1 with water in the water truck's tank. The product binds fine dust particles together, preventing them from becoming airborne. This extends the time frame for rewatering by hours or even days.

Pinto Valley tested it in the summer of 2022 on some high-traffic roads and were very happy with how it performed. To make the best use

of an expensive product, they apply it as a spot treatment on fixed roads, but not temporary roads deep in the pit that may only be used for a week. Jugler estimates that two thirds of their roads are being treated regularly, with benefits for those who drive the water trucks. "It makes the water truck operators' life simpler. They're not constantly refilling, so they can take a moment to breathe," Jugler said.

He finds the improvement in dust suppression is very noticeable and air quality testing backs this up. For him, the evidence is there every morning. "When the sun comes up as you're driving into the mine, the first thing you notice coming down that hill is that there isn't a haze," Jugler said.

Sustaining Biodiversity

The ecosystem for the Sonoran Desert, where Pinto Valley operates, is fragile due to extreme weather conditions and human development of the land. Bordered by the Tonto National Forest, it is situated in the Pinto Creek watershed. The recent completion of an Environmental Impact Statement and approval of a Mine Plan of Operations for Pinto Valley's expansion project will bring additional monitoring and mitigation measures.

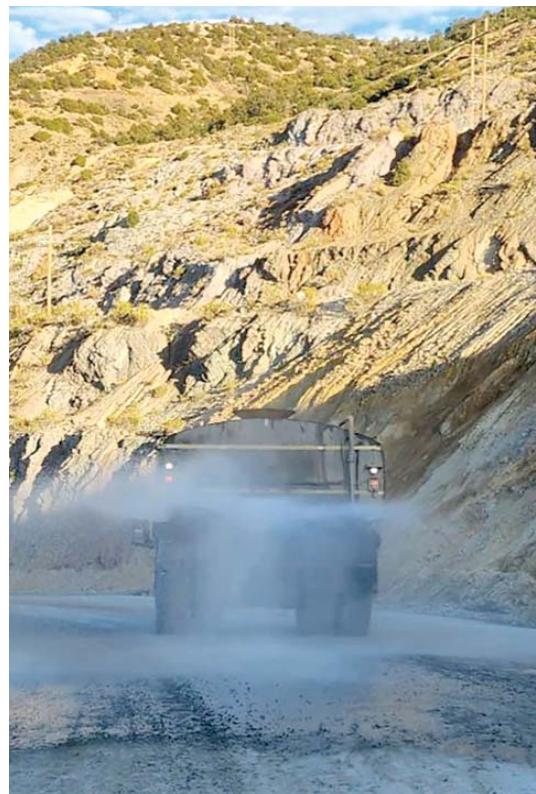
Pinto Valley actively mitigates risks of potential acid rock drainage associated with surface water runoff by encapsulating waste rock and tailings with inert materials. Alternately, they capture and recycle surface water runoff that contacts these materials in a network of catchments, ponds, and reservoirs. Groundwater quality is protected by the hydraulic capture zone created by the open pit, active pumping of downgradient water production wells, and high evaporation rates on the surface of waste dumps and tailings impoundments.

The reclamation activities planned for Pinto Valley's mine closure (currently projected for 2039) will include landform regrading and contouring, and revegetation with native plant spe-

cies. The mine has created vegetation reference plots to monitor the success of species for revegetation potential.

The mining operation also makes use of appropriate equipment and operational practices to reduce dust. Equipment solutions include wet scrubbers on conveyor belts and enclosures or covers on dust-prone areas such as conveyors, stockpiles and concentrate storage. In 2022, Pinto Valley replaced seven dust collectors with modern, efficient cartridge filter units that do not require water, unlike the old wet scrubbers.

Air quality monitoring, for both worker safety and environmental protection, ensures Pinto Valley meets regulatory standards and quickly responds to issues. All Capstone sites monitor or conduct sampling for fine particulate matter (PM), specifically PM10 and PM2.5. Pinto Valley conducts annual stack testing to ensure dust control equipment is functioning as expected. It also uses visual monitoring for



Pinto Valley uses a 1:1 ratio of magnesium chloride to water in its water trucks to suppress dust. (Photo: Capstone Copper)

dust, based on approved procedures for gauging opacity. The site records observations and uses them to activate contingency measures.

Pinto Valley submits an annual emissions inventory report to the Arizona Department of Environmental Quality (ADEQ). In addition to reporting PM emissions from all sources, they are also required to report carbon monoxide, volatile organic compounds, nitrogen oxides and sulphur oxides from stationary sources (e.g., internal combustion engines, boilers, heaters) but not from mobile equipment or vehicles.

The mine's tank house generates hazardous air pollutants (HAP) pri-

marily related to sulphuric acid mist from the electrowinning process. HAP emissions dropped 27% in 2022 when an updated emissions factor issued by ADEQ was applied.

Cleaning the Air and Saving Water

Crushing and grinding ore can generate a lot of dust. Since PM is unhealthy for people and ecosystems, it's important to prevent it from escaping. Pinto Valley's Mill Maintenance Superintendent Brandon Greer explained that the original dust collectors (i.e., wet scrubbers) in the Pinto Valley mill worked by ventilating dust laden air and spraying it with water to capture dust before releasing it outdoors. "The old scrubbers were essential for meeting our permits, but they were showing fatigue, and we were always doing maintenance to keep up," he said.

Replacing the old wet scrubbers with new models that require no water was a clear win-win situation. In 2022, Pinto Valley replaced seven dust collectors with filter cartridges that contain 12 filters in each unit. After a year of operation, Greer said he was impressed with the result. "I feel like you can see the difference in emissions, and the units are much more efficient to operate," Greer said. Performance testing of the stacks associated with the new units showed a 10-fold reduction in PM10 emissions from these seven sources.

Even more impressive to Greer are the water savings from the switch. "Each of the units we replaced ran through approximately 20 gallons per minute (gpm) of water, round the clock," he explained. "That's a big savings. Any way we can salvage our water resource by using it as minimally as possible, while still operating efficiently, just makes sense." Capstone plans to replace an additional two wet scrubbers with high-efficiency cartridge filter units at Pinto Valley.

Supporting Mental Health

When nurse practitioner Jody Vines joined the Pinto Valley team six years



Pinto Valley invested 10 hours/day for six months to identify, document and recover evidence of past use for further analysis by archaeologists. (Photo: Capstone Copper).

ago, she became part of a new on-site clinic at the mine. This clinic was created to perform health checks required by the regulator, as well as injury assessments. Because it's on site, the clinic is convenient for employees and is lower in cost.

An even bigger benefit of the on-site clinic has been the presence of a compassionate ear for any employee experiencing mental health stress. Pinto Valley offers an employee assistance plan to access counselling and rehabilitation for mental health and substance use disorders. Vines is in a position to help employees make the most of that program. "It can be frustrating to navigate the medical world," Vines said. "I can ease that burden."

Capstone said the COVID-19 pandemic shed light on a growing mental health crisis that affects all of its sites and communities. The counties around Pinto Valley have seen an escalation in substance abuse, opioid addiction



The mine realized 20 gpm in water savings by replacing old wet scrubbers with new, water-free dust collectors. (Photo: Capstone Copper)

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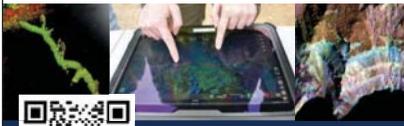
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and overdoses, with devastating consequences for people and their families. At a 24-hour operation there is an additional stress factor, Vines explained. “Shift work is not easy on people,” she said. “It takes them away from their family on evenings and weekends.”

Even though mental health issues are widespread and better understood than they were a few years ago, it’s still not easy for employees to open up about their struggles. To address that, Vines’ team partnered with Blue Cross Blue Shield to launch mental health first aid classes (the mental health equivalent of a CPR certificate). In an 8-hour class, employees develop the skills to notice and support an individual who may be experiencing a mental health or substance use concern or crisis. They also learn how to initiate uncomfortable conversations with their fellow workers.

“Whether someone is struggling personally, or having trouble at home, an expression of empathy can make all the difference,” Vines said. “Just ask: Is there anything going on that you would like to talk about? I’m willing to listen.”

Workforce Retention

Pinto Valley had a higher-than-average turnover rate due to labor shortages and changing employee expectations in the Arizona labor market, a trend it said was most noticeable in the under-30 category.

Pinto Valley signed a 4-year collective bargaining agreement in August 2022, resulting in significant improvements for employees. These include more competitive wages and benefits and improved leave practices. The new agreement also permits Pinto Valley to make future wage increases without re-opening bargaining.

Respecting Cultural Heritage

Pinto Valley’s operations overlap with parts of the Tonto National Forest. Several prehistoric peoples lived by hunting and gathering in this area. The peoples who succeeded them, including the Hohokam and Salado, practiced

farming, building and trade, leaving their marks on the landscape when they left the area. Their descendants include members of the Hopi, Pima and Zuni tribes who live in the area today.

Selwyn Selina belongs to a Hopi Bear clan and maintains a strong attachment to these ancient cultures. He works as a Tribal Monitor Crew Chief for Westland Resources through a program that is giving a voice to the various tribes that need to be consulted before disturbing cultural artifacts. Pinto Valley’s plan to upgrade its TSF requires extension onto some land within the Tonto National Forest. The Tribal Monitors were engaged to help identify, document and, in some cases, recover the evidence of past use, for further analysis by archaeologists.

Working 10 hours a day for almost six months, Selina’s team discovered a variety of archaeological features, such as ancient house blocks, the foundation of a compound with many rooms, a roasting oven and even two tiny beads. The investigation and exhumation of archaeological finds is painstaking and hard on the body, but Selina finds it very meaningful. “It’s important that I’m here to see this with my own eyes, and document in my own words what was here, to pass this on to my people,” he said.

He is not troubled by the understanding that once they are done, the land will be cleared. “There’s got to be change,” he said. “People have always adapted. I believe that my connection to that area is not altered even if those things are no longer there. We still celebrate and do the ceremonies, knowing what was there.”

Selina takes satisfaction in learning more about the people who came before. “What I appreciate the most is visually understanding what they were doing here,” he says. “Why did they come here? The unknown is the fascinating part.” Selina’s perspective is now shared widely with Pinto Valley employees and contractors, and he was asked to record a video for cultural awareness.



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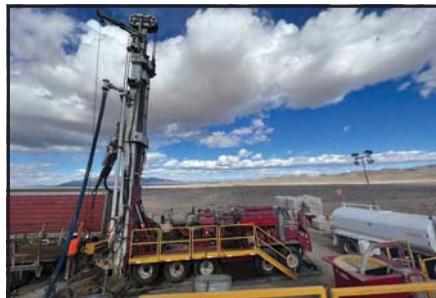
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South32's Hermosa Project Achieves Key Operational Milestones

Permitting is on the FAST-41 track and exploration continues to further define the orebody



South32 begins construction activity on an exploration shaft at Hermosa, which will be used to further define one of the world's largest undeveloped zinc resources. (Photo: South32)

South32's Hermosa project announced a series of project developments that highlights its commitment to investing in and partnering with the community to bolster workforce development and community health transparency. This includes the formation of the South32 Hermosa Workforce Development Taskforce, the hiring of public health experts to guide the Santa Cruz County community health assessment and outreach to local public health institutions, and a construction update on the main exploration shaft.

"We are designing the Hermosa project with state-of-the-art technology to be a safer, more sustainable, and more advanced mine," said Hermosa Project President Pat Risner. "We are excited to share our progress as we work to reduce America's reliance on foreign countries for critical minerals, while unlocking new economic opportunities for this community."

FAST-41 Designation

South32 has been active in southern Arizona for more than five years now, Ris-

ner explained. "We are proud of what we have achieved in this short amount of time as we continue designing the Hermosa project to be a mine that's safer and more sustainable than anything Arizonans have seen," he said. "Hermosa will also reduce America's reliance on foreign countries for the resources found at our site and strengthen our domestic supply of manganese and zinc – both designated critical minerals."

To operate, Hermosa needs a series of state and federal permits. In May 2023, South32 Hermosa was the first critical minerals project to be designated as a FAST-41 project.

FAST-41's "FAST" acronym stands for "Fixing America's Surface Transportation," the name of the bill that created the Federal Permitting Improvement Steering Council (FPISC), an independent federal agency responsible for environmental reviews and permitting for infrastructure projects.

In July 2023, the FPISC published a proposed comprehensive, integrated permitting timetable for South32's Hermosa project. It includes interme-

diated and final completion dates for all federal environmental reviews and authorizations for full project development, as well as a list of cooperating agencies. The proposed permitting timetable projects Hermosa will happen in three phases.

Because FAST-41 at the outset will make the rigorous federal environmental review and permitting process for this project more transparent, predictable, and inclusive for all stakeholders, South32 is well positioned to bring this project into operation in a way that benefits the community, minimizes impact on the environment, and creates new opportunities across the region in the years to come, Risner explained.

"We are looking forward to 2024 as a year in which we will complete our feasibility studies, continue our construction process and develop a homegrown workforce with the next-generation skills needed to operate the Hermosa project and support our broader community for generations to come," Risner said.

Continuing Project Construction

In May, the Hermosa project began initial excavation for the main exploration shaft and the ventilation shaft to provide underground access to the Taylor deposit.

During December 2023, Hermosa announced that construction pre-sink activities of both shafts remain on track. To date, we have excavated 50 of the planned 115 feet for the main exploration shaft and excavated 115 feet for a ventilation shaft. While total depth of the shafts is approximately 2,900 feet, achieving these construction milestones will allow for infrastructure needed for safe passage of people and vehicles underground.

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“This construction demonstrates the continued progress of the Hermosa project toward delivering critical minerals to the market which would reduce America’s reliance on foreign countries and strengthen domestic supply of critical minerals. This advanced, underground mining method enables reduced surface impact and the amount of tailings resulting in a more sustainable mine,” said Hermosa project Vice President of Project Delivery Andy Thompson.

Supporting Workforce Development

The main purpose of the South32 Hermosa Workforce Development Taskforce is to identify the skills needed and local facilities available to help train, develop and expand the region’s workforce.

“The first step in helping transform the local economy is partnering with community members whose expertise and understanding of our region’s edu-

cational needs can help create opportunities, so that the next generation can stay in Santa Cruz County,” said South32 Human Resources Director for North America Skylie Estep. “This partnership will allow us to develop a clear, specific pathway for training local residents to fill the high-skilled, good-paying jobs Hermosa will bring to the region.”

The taskforce will begin meeting in 2024. Confirmed members include:

- Angelina Canto, Nogales Unified School District # 1 Superintendent;
- Victoria Clark, Business Development Director, Pima Community College;
- Skylie Estep, South32 Human Resources Director for North America;
- Manuel Felix, AZ Cyber Initiative;
- Naiz Garibay, South32 Project Supporter Coordinator;
- Patrick Garretson, South32 Study Manager;
- Kenny Hayes, Patagonia Public Schools Superintendent;

- Greg Lucero, Santa Cruz County Workforce Development Steering Committee;
- Kari Middleton, Pima Community College;
- Sandra Moraga, South32 Communities Specialist;
- Stephanie Moreno, South32 Tribal Affairs Specialist;
- Akmaral Muken, South32 Training and Learning Principal;
- Irasema Olvera, Arizona @ Work;
- Josh Rubin, Greater Nogales Santa Cruz County Port Authority;
- David Verdugo, Santa Cruz Valley Unified School District No. 35 Superintendent; and
- Chris Young, Chief Deputy Santa Cruz County School Superintendent’s Office.

Setting a New Standard for Safety and Sustainability

The Hermosa project has hired Ram-boll, a global consulting firm with de-



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ades of experience conducting community health assessments in southern Arizona and across the United States, to guide South32's Santa Cruz County baseline community health assessment and outreach to local public health institutions, including the University of Arizona.

A baseline assessment will help Hermosa limit the exposure of manganese and other minerals. By understanding what already exists in the community and environment before operations begin, South32 can make sure health and safety controls are in place, better understand any changes over time, and ensure controls remain effective throughout the life of Hermosa.

"We know our families, friends and neighbors are counting on us to get this right," said Hermosa Project Communities Principal Melanie Lawson. "That's why we are partnering with third-party public health organizations to regularly monitor and

report findings to ensure transparency and accountability."

Two professionals will lead Ram-boll's efforts at the Hermosa project: Rosalind Schoof, Ph.D., Diplomate of the American Board of Toxicology (DABT), Fellow ATS, and Alma Feldpausch, MS, DABT.

Updated Mineral Resource Estimate

In July 2023, South32 updated the mineral resource estimate for the Hermosa project, which includes the Taylor zinc-lead-silver deposit, the Clark battery-grade manganese deposit, and the Peake deposit.

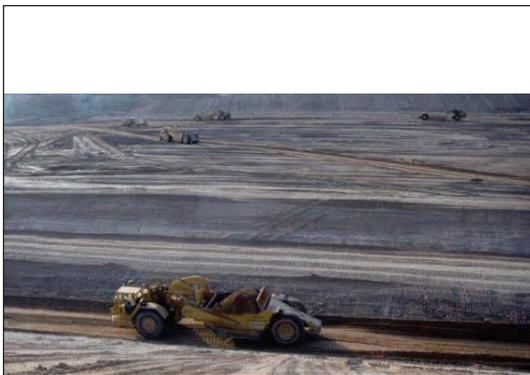
The Taylor Mineral resource estimate is estimated at 153 million metric tons (mt), averaging 3.53% zinc, 3.83% lead and 77 g/mt silver. The upgrade includes a 41% increase in the measured mineral resource estimate, providing a compelling base to underpin future production. The deposit remains open

in several directions, offering the potential for further growth. This zinc resource in the Taylor deposit would be one of the world's largest undeveloped resources, which is also a federally designated critical mineral in the USA.

South32 also published information on the Peake deposit, which is a copper-lead-zinc-silver prospect, a lateral zone prospective for copper mineralization, located south of the Taylor deposit.

The results included the best intercept at Peake to date, with diamond drill hole HDS-813 returning a down-hole intersection of 139 m grading 1.88% copper, 0.51% lead, 0.34% zinc and 52g/mt silver at 2.49% copper equivalent (CuEq), including 58.2 m grading 3.1% copper, 0.6% lead, 0.24% zinc, 74g/mt silver and 0.015% molybdenum at 3.84% CuEq.

These days a grade above 1% would be considered rich and South32 said it is planning further exploration drilling at Peake in 2024.



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Advanced leaching technology could unlock stranded copper

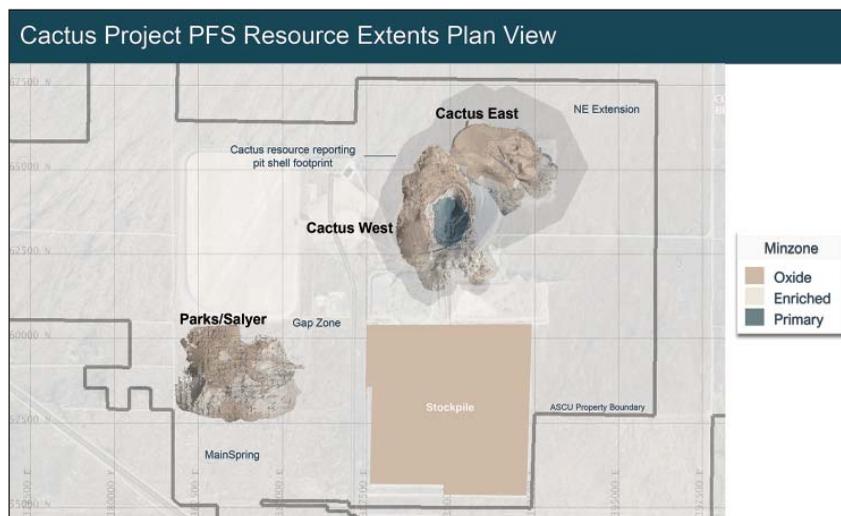
Last year was an exciting year for the Arizona Sonoran Copper Co. (ASCU), an emerging copper developer based in Casa Grande, Arizona. In February 2023, the company optioned an additional 523 acres of private land contiguous to Parks/Salyer known as MainSpring, for a total cash consideration of \$14 million. Then they hired Ausenco to lead the team producing its prefeasibility study (PFS) on the Cactus project. The company expects to have that completed in Q1 2024.

ASCU has also demonstrated the ability to obtain major permits from the regulators with the support from community. The company received both a Mined Land Reclamation Permit and the Industrial Air Permit in early 2023. The framework to receive the remaining permits will be guided by the pending PFS and a future construction decision. The project benefits from water rights to a permitted water source, as well as a streamlined state and local municipality permitting process. Working with a brownfields project on private land avoids the federal permitting process.

Based on the metallurgical test work performed so far, ASCU is targeting a step up from the Preliminary Economic Assessment's (PEA) 28,000 tons per year of copper to 45-50,000 tons per year of copper and extending the mine life well beyond the 18 years previously outlined.

More recently, the company announced an option for a joint venture with Nuton, LLC, a subsidiary of Rio Tinto that has a promising method for enhancing the leaching process. If Nuton can show that its technology can improve the net present value (NPV) of the Cactus project above a certain threshold, it could buy up to 40% of the Cactus project for \$33 million.

"The company continues to deliver on its key objectives," said George



ASCU controls the Cactus East, Cactus West, Parks/Salyer and now the MainSpring property. (Source: ASCU)

Ogilvie, CEO, ASCU. "Ongoing work programs include our advanced metallurgical programs, final engineering, mine planning and site characterizations as we progress towards our PFS. Our drilling also continues, both infill and exploration." All this work is preparing the company for future technical studies and an eventual decision to move into a construction and development phase.

The Nuton Option

During mid-December, ASCU entered into an option-to-joint-venture agreement with Nuton to establish a strategic alliance for deployment of Nuton's leaching technologies at its Cactus mine and the Parks/Salyer project, which are collectively known as the Cactus project.

"We welcome the expertise and financial support as we expand testing of Nuton's heap leaching technologies, while concurrently advancing ASCU's projects," Ogilvie said. "Nuton's column test results have demonstrated continued improvements in extraction rates from both the primary and enriched mineral resources, resulting in potentially more efficient

operations. We look forward to advancing into Phase 2 testing, which includes an expanded understanding of the Nuton technologies' economic benefits within a fully integrated PFS, anticipated by the end of 2024.

ASCU granted Nuton the option-to-joint-venture for \$33 million. Nuton could acquire 35%-40% of the Cactus project with a further payment based on 35-40% of the NPV, and using a multiple of 0.65x. Nuton will pay \$10 million to ASCU at signing of the option agreement; ASCU can draw up to \$11 million in the form of a pre-payment toward the Option Exercise Price; and Nuton will make up to \$12 million available to ASCU for funding costs associated with continued Nuton test work required to produce the Integrated Nuton Case (INC) PFS.

"Successful deployment of Nuton Technologies at Cactus and Park/Salyer has the potential to materially enhance the economic and environmental performance of the projects," said Adam Burley, CEO of Nuton.

Nuton said its technologies can unlock copper from sulphide resources, copper bearing waste and tailings, and



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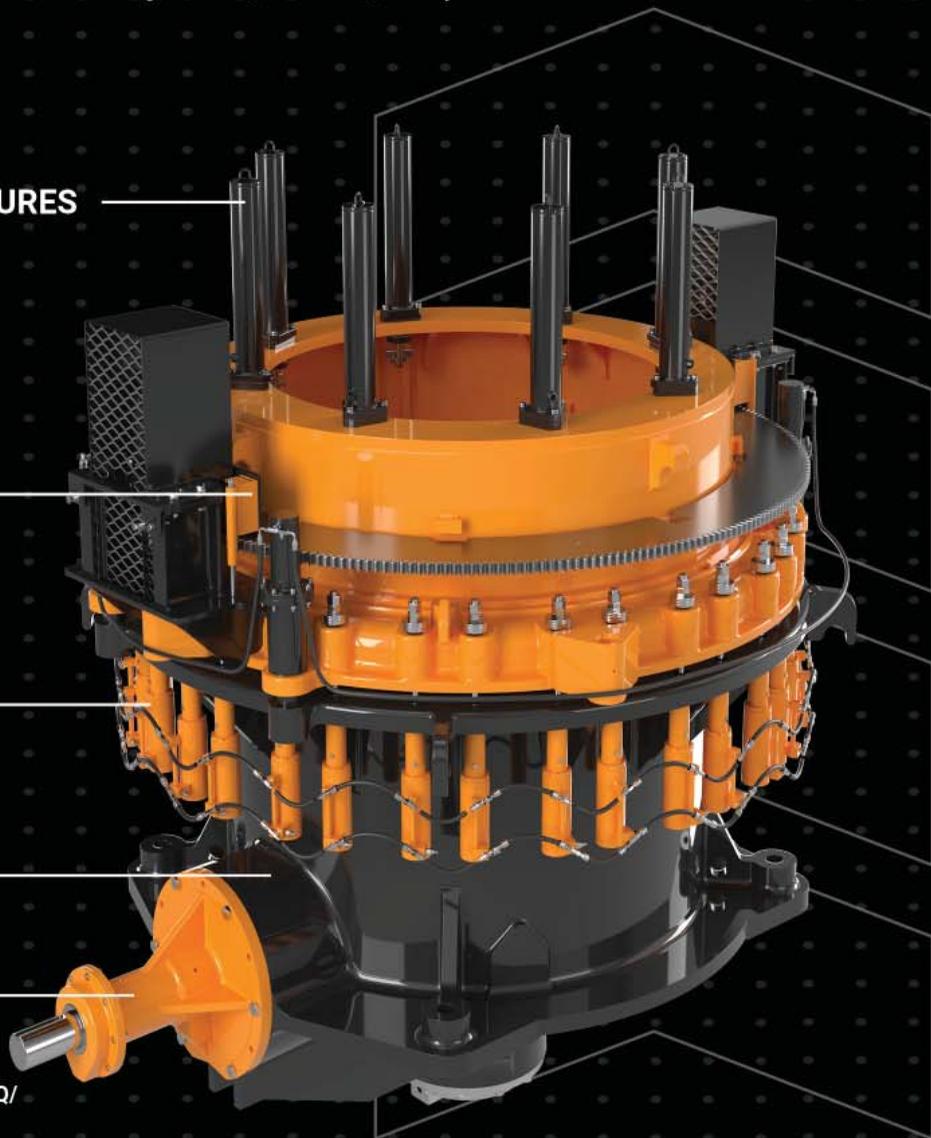
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Cactus Mineral Resource: Lower Risk Copper Porphyry Project

Permits, water, infrastructure and a substantial mineral resource with a focus on the leachable resource for a proposed heap leach and SXEW operation on 5,370 acres



Cactus Project Mineral Resource Estimate (As at August 31, 2023)			
	Tons kt	Grade Cu%*	Pounds Cu Mlbs
Total Measured	10,400	0.241	49.8
Leachable	9,100	0.230*	41.9
Primary	1,300	0.315	8.0
Total Indicated	435,300	0.589	5,124.2
Leachable	348,500	0.629*	4,387.2
Primary	86,800	0.425	737.0
Total M&I	445,700	0.580	5,174.0
Leachable	357,600	0.619*	4,429.0
Primary	88,000	0.423	745.0
Total Inferred	233,800	0.472	2,207.9
Leachable	107,700	0.607*	1,307.9
Primary	126,200	0.357	900.0

The current mineral resource (MRE) estimate for the Cactus project positions it as the third largest independent copper project in the USA. (Source: ASCU)

achieve higher copper recoveries on oxide and transitional material, which could significantly increase copper production. One of the key differentiators of its technology, according to Nuton, is the potential to deliver leading environmental performance, including more efficient water usage, lower carbon emissions, and the ability to reclaim mine sites by reprocessing mine waste.

Nuton’s heap leaching technology would allow ASCU to access currently stranded primary mineral resources while also incrementally improving the copper extraction rates from the enriched material. Nuton believes its flowsheet could be easily integrated into the planned Cactus heap leach and solvent extraction/electrowinning (SX/EW) flowsheet.

“The proposed heap leach and SX/EW flowsheet using Nuton is intended to build upon the strength of our standalone base case, using the same infrastructure,” Ogilvie said. “Nuton has indicated the potential to significantly increase copper cathode output from our current 45,000 to 50,000 mt/y target which could materially enhance project economics.” The two companies have outlined a work program for the Nuton Case to commence in Q1 2024, targeting delivery of the INC PFS, by December 31, 2024.

For Nuton to acquire its stake in the Cactus project, it must demonstrate that the net present value (NPV) of the Cactus project after applying the Nuton technologies is at least 1.39 times the NPV of the Cactus Project without applying it. If the MainSpring property, which is currently the subject of exploration efforts, becomes material to ASCU and incorporated into its PFS, then Nuton would have to show at least

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1.20 times the NPV for the Cactus project to achieve the option.

Lab Results Look Promising

The metallurgical results from the Nuton Phase 1 column leach program from the Cactus project indicate that Nuton's technologies would enhance recovery rates.

"We are encouraged by the extraction rates resulting from our primary and secondary sulphides using the Nuton technologies," Ogilvie said.

The Phase 1 scope included column testing of the Cactus sulphides, primary and enriched, using the proprietary Nuton additives within a traditional heap leach and SX/EW flowsheet. Testing included a variety of conditions, including operating temperatures and additive schemes. Nuton and ASCU are currently planning a Phase 2 column leach program. Phase 2 would be designed to test and/or mitigate opportunities and threats identified under the Phase 1 test program.

Advancing the PFS

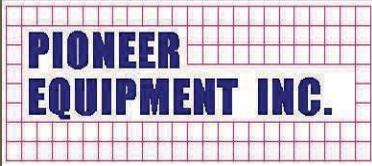
The PFS is being led by Ausenco and a team of consultants comprised of Samuel Engineering, AGP Mining Consultants, Stantec, MineFill Services, Clear Creek Associates and Call & Nicholas Inc. The company and its consultants are scoping the oxide and enriched material from Cactus and Parks/Salyer mineral resource estimates for a 45-50,000 mt/y heap leach operation with an onsite SX/EW plant to produce LME grade A copper cathode. Currently, ASCU's copper resource contains 5.17 billion lb of indicated and 2.21 billion lb of inferred resources, which would be the third largest independent copper deposit within the USA.

As of September 2023, the process design criteria and sizing of the SX/EW plant for the PFS was complete. The engineers were assessing long-lead components, equipment specifications and requirements. Underground and open pit mining methods, heap leach and associated infrastructure

designs were being reviewed and optimized to ensure an economic and practical approach to mining. Geotechnical and hydrological work was nearing completion with final assessments to be based on ongoing engineering.

ASCU has completed two years of metallurgical testing to the PFS level at Parks/Salyer and Cactus. The company reported that metallurgical column leach testing and hydrodynamic testing supports multi lift leach pads when crushed to a top size of minus 1-in. (25 mm). Depending on the deposit, enriched material recoveries range from 80%-76% and the oxides recoveries range from 92%-88%.

Prior to the Nuton option announcement, ASCU released preliminary extraction rates of 61%-82% for primary sulphide material from Stage 1 Nuton column testing after completing 50% of the 300-day cycle under the testing program. Extraction rates indicate the potential to achieve an optimized 80% life of mine extraction rate for primary sulphides.



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University of Arizona's New School Addresses Critical Need for Minerals and Mining Talent

Clean energy demands more minerals and more mining professionals. Meeting this need will require investment in mining talent and innovation, both of which are happening at the University of Arizona's new School of Mining & Mineral Resources.

By Mark Barton, Misael Cabrera, Carmie Garziona, David Hahn, and Kray Luxbacher

As the global energy system transitions into a low-carbon future, the demand for mineral resources has never been greater. Technologies like solar panels, wind turbines, and electric cars require minerals such as copper, silver, lithium, cobalt, nickel, and rare earth elements in increasing quantities, creating rapidly growing markets to fuel this development on a global scale.

Organizations such as the World Bank Group and International Energy Agency have identified risks to this planned transition to clean energy, and top among them is a shortage in critical minerals.^{1,2} Left unaddressed, these shortages can make a clean energy future slower to achieve and more costly and create disruptions and volatility in global markets and supply chains.

But another critical challenge must be overcome on the path to a greener



The Geotechnical Center of Excellence fills knowledge gaps for professionals working in the field. (Photo: UofA)

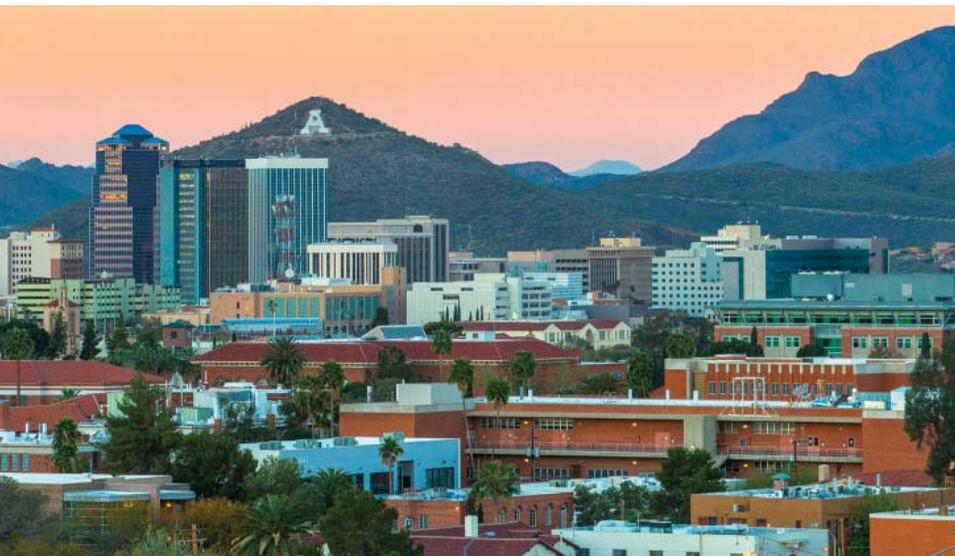
future: the global shortage of mining talent. While the demand for mineral resources — and the workforce to extract them — is increasing, fewer students are choosing to enter this field. The impact is being felt worldwide,

with 71% of mining leaders reporting in 2022 that the talent shortage is keeping them from meeting production targets and strategic objectives.³

Mining and Minerals Careers, Redefined

The University of Arizona is meeting this challenge head-on. The transdisciplinary School of Mining & Mineral Resources was created to fill the workforce gap with emerging talent, to revolutionize the way mining is being taught, and to deliver holistic solutions for industry through research that combines disciplines from across campus. The school formally brings together multiple programs, centers and facilities around a shared vision of advancing sustainable mining and mineral exploration. This unique “innovation ecosystem” can be found nowhere else in the world.

Anchored by top-ranked programs in mining engineering and



The University of Arizona supports the advancement of mining by investing in research and development across the entire mining life cycle. (Photo: UofA)

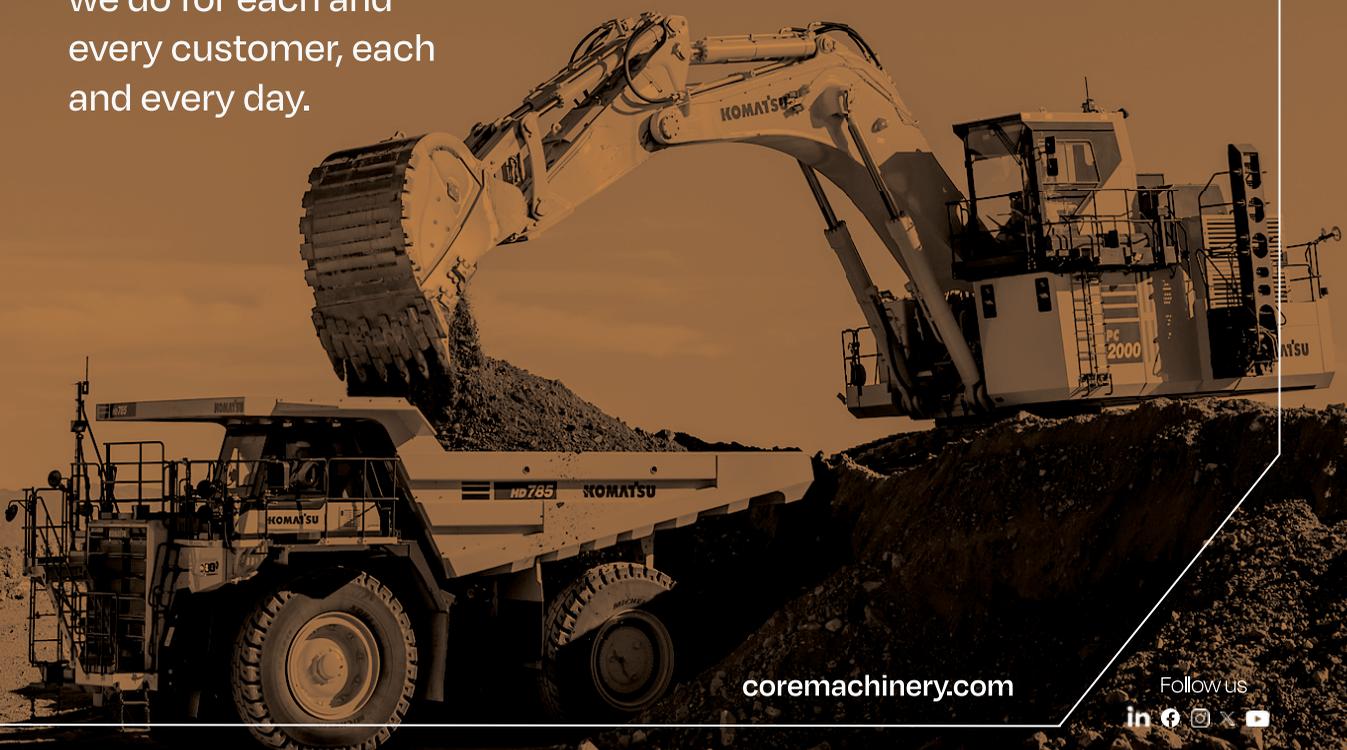


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Mining School in Arizona's "Silicon Valley" Drives Innovation and Addresses Workforce Gaps

The Grand Canyon State may not be the first thought when one hears the words, "Silicon Valley," but for those close to the mining industry, the association is clear. Arizona offers a rich ecosystem of ore deposits, hosts more than 400 major hardrock and aggregate mines, boasts more than 200 mining technology suppliers, and houses top mineral research institutions. And the region south of Phoenix serves as the home to the Caterpillar and Komatsu proving grounds, as well as a city that ranks as a top emerging U.S. tech market.

Based in Tucson, the University of Arizona is the epicenter of a growing innovation ecosystem dubbed the 'Silicon Valley of mining' by industry experts, educators, and government leaders. With more than 2,700 invention disclosures and 130 plus start-ups launched, this Tier 1 research institution is driving technological advancements across numerous industries, including mineral resources. Possessing more than a century of mining education experience, the university recently launched a school focused on spearheading industry-advancing research and modernizing educational programs for miners and non-miners alike, at every stage of learning.

Investing in Research and Technology

In its inaugural year, the School of Mining & Mineral Resources at the University of Arizona has mobilized dozens of faculty members, researchers, students, and staff, to collaborate on 25 research projects spanning 25 departments. These initiatives cover early-stage research topics such as eco-friendly dust suppression compounds, acid mist suppressants to enhance worker safety, carbon sequestration utilizing mine tailings, and other pioneering ventures, many on the path of commercialization.

Recent research highlights include a \$3.6 million Regents' Research Grant to help university scientists assess the metal content from mine tailings throughout the state in search of critical elements such as lithium; a min-

Article Continued on Page 36



By updating curriculum to reflect the realities of mining and economic geology in the age of AI and autonomous systems, the School of Mining & Mineral Resources is addressing the industry's needs. (Photo: UofA)

economic geology, the university supports the advancement of mining by investing in research and development across the entire mining life cycle. Through facilities like its Tailings Center and Center for Environmentally Sustainable Mining, the university works with industry to improve operational processes and reduce the environmental impacts of mining. The Lowell Institute of Mineral Resources and the Geotechnical Center of Excellence engage industry to innovate and fill knowledge gaps for professionals working in the field. Our Centers for Mining Safety and Superfund Research advance the most pressing issues related to improving mine safety and enhancing health and environmental outcomes. Through these and other projects, students contribute to solving real-world problems and develop the kinds of skills that no ordinary education can deliver.

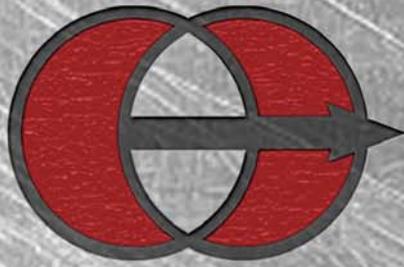
One of the ways the university is addressing the talent shortage is by increasing the aperture of who studies mining. Research done by the University of Arizona⁴ shows that most students are aware of mining and its economic importance, however, they don't know about the critical role of mining in securing our future. Through community outreach programs beginning in elementary education, the School of Mining & Mineral Resources is helping spread awareness of the importance of sustainable mining practices.

Through virtual and in-classroom presentations, students engage in hands-on activities illustrating mine design, mineral extraction, and mine site reclamation. Modern mines are technologically advanced, driven by robotics and AI, requiring cross-functional skills across a wide range of disciplines that can match any interest. By outlining the diverse array of educational opportunities and career pathways that mining presents, the school is helping young people envision a future in mining by seeing themselves in those careers.

Mining and Minerals Education, Reimagined

The School of Mining & Mineral Resources is breaking down educational silos and meeting the call to modernize curriculum by working with industry partners to develop the skills needed in the workforce of the future, and we're doing it today. Industry has asked it to deliver talent with knowledge of environmental and social issues, with better communication skills, and with more hands-on experience and business savvy. And the school is doing just that by updating existing courses, developing new offerings, and leveraging the unique San Xavier Mining Laboratory.

For the multitude of mining industry careers that are not based in engineering or science, the School of Mining & Mineral Resources offers a minor degree in Sustainable Mineral Resources so that accountants, supply chain



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ing engineering cyber-physical systems partnership with Antofagasta plc; the formation of the Hyperspectral Research Consortium; and numerous partnerships between faculty and global industry leaders to advance mining automation technologies driven by robotics, AI, and machine learning.

The Hub of a Vibrant Mining Innovation Ecosystem

Recognizing the demand for upskilling existing workers, the school's Geotechnical Center of Excellence offers courses in structural geology, radar and slope monitoring, and water in mine operations, and has trained more than 1,900 working professionals from 45 countries. GCE's industrial partners also benefit from research projects like the comparison of different types of synthetic aperture radar (SAR) to aid in more effective monitoring of mining sites. A recent National Institute for Occupational Safety and Health (NIOSH) grant is supporting a test of various models of thermal imaging cameras at open pit mines around the country to see if they can predict rockfalls and slides before they occur. If successful, this research could potentially save miners from injury or death caused by slope failures.

Holding a degree is often not a prerequisite for professional development programs. The school provides underground rescue training for the military and delivers critical safety courses for industry through the Mining Safety Center of Excellence. With an emphasis on mining sustainability

from the workforce perspective, SCE is a research, education, and training community that innovates mining methods in pursuit of achieving zero injuries, illnesses, and fatalities.

Central to its mission to provide hands-on, experiential learning, the University of Arizona owns the San Xavier Underground Mining Laboratory, a multi-level training facility. The only underground mining laboratory in the U.S. with a working vertical shaft, the site has a rich history as a teaching, research, and training site. The mine has four levels of underground workings to a depth of 250 feet. This training facility has attracted projects critical to national defense, geosciences, and mine rescue.

Advancing the Future of Mining

Undergraduate programs emphasize modernized curriculum in tracks for mining engineering, geosciences, and hydrology, among other mining-related disciplines. By updating curriculum to reflect the realities of mining and economic geology in the age of AI and autonomous systems, the school is answering the call from industry to produce a highly prepared, transdisciplinary workforce capable of meeting the growing demand for cross-functional and high-tech skills.

To learn more about the innovative research taking place through the School of Mining & Mineral Resources in Tucson, Arizona, mining's own Silicon Valley, explore the website at mining.arizona.edu.



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specialists, human resources professionals, and others can be familiar with mining topics before their first day on the job. The university is also delivering professional development and graduate-level courses for existing professionals in topics like ore deposits mapping, slope performance monitoring, and integrated mine planning. For those seeking a Master's in Legal Studies degree from the College of Law, the Mining Law and Policy Concentration offers more than 15 mining-specific courses.

Mining and Minerals Research, Reinvigorated

In just the first 12 months of its existence, the School of Mining & Mineral Resources has engaged more than 50 faculty, researchers, students and staff on more than 25 research projects across 25 departments. These early-stage research projects include eco-friendly dust suppression compounds, acid mist suppressants for worker safety, carbon sequestration using mine tailings, and other very promising projects. Researchers even created an app for hazard recognition in underground mines!

By focusing on the challenges that the mining industry is facing today, the School of Mining & Mineral Resources is proving itself to be a high-value, long-term partner, helping to secure sustainable mineral resources for generations to come. To learn more about how the University of Arizona is reimagining mining and minerals education visit mining.arizona.edu and explore the school and the university's many programs.

Mark Barton is the director of the Lowell Institute for Mineral Resources; Misael Cabrera is the director of the School of Mining & Mineral Resources; Carmie Garzione is the dean of the College of Science; David Hahn is the dean of the College of Engineering; Kray Luxbacher is the department head for Mining and

Geological Engineering at the University of Arizona.

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Construction Begins on Florence Copper's Wellfield

Taseko finds additional early-stage funding to achieve production

When it reaches full production, Taseko Mines' Florence Copper project, located near Florence, Arizona, will be one of the greenest and lowest cost sources of copper for U.S. domestic consumption. The project will use an in-situ copper recovery method to extract copper in solution with far less disturbed land. That also translates into dramatically lower carbon emissions, and lower water and energy consumption compared to conventional open-pit copper mines. The operation is expected to produce 85 million lb/y of LME Grade A copper cathode, which is now defined as a critical material by the Department of Energy, to the U.S. domestic market.

Florence Copper made advancements on several fronts during 2023, including the receipt of the final Underground Injection Control (UIC) permit from the U.S. Environmental Protection Agency (EPA). The EPA received no appeals or objections and the UIC permit became effective on October 31, 2023. The company also found an additional \$100 million in funding based on royalty and debt agreements. With financing and permitting in place, site preparation and clearing for the initial wellfield, plant and infrastructure began in Q4 2023. The hope is that wellfield drilling will commence in Q1 2024.

"Successful completion of the UIC permitting process was a result of Taseko's long-term development

approach, and the quality and environmental integrity of the project," said Stuart McDonald, president and CEO of Taseko. "Taseko is now in a unique position, with one of the very few fully permitted mining projects in North America. With the final permit in hand, we have a clear line of vision to commercial production and are that much closer to realizing the full value of Florence Copper."

Advancing Toward Production

The next steps for Florence Copper include procurement of materials and supplies and finalizing agreements with key contractors, including the general contractor for the solvent extraction/electrowinning (SX/EW) plant and the drilling contractors for wellfield development. The company has also been hiring additional management and site personnel for the construction and operations teams.

Detailed engineering and design for the commercial production facility is substantially completed and procurement activities are well advanced. Major processing equipment associated with the SX/EW plant has been purchased and delivered to the site. Through the first nine months of 2023, Taseko invested C\$45 million (\$33.6 million) in Florence Copper.

The company has also secured project level financing to fund con-

struction activities. During October, Taseko closed the first \$20 million tranche of its \$25 million equipment loan commitment from Bank of America for Florence Copper. The company's financial adviser, Endeavour Financial, secured commitments of approximately \$100 million in royalties and debt for Florence Copper, in addition to the commitments already received from Mitsui and Bank of America.

In March 2023, the company filed an NI 43-101 Technical Report for Florence Copper with updated capital and operating costs for the commercial production facility and the report also refined the operating models based on the results from the Production Test Facility (PTF).

Some of the highlights from the technical report include a net present value of \$930 million with an internal rate of return of 47% (after-tax) and a payback period of 2.6 years. Operating costs are projected to be \$1.11/lb of copper. Over the course of the \$232 million project's 22-year life, it's expected to produce a total of 1.5 billion lb of copper.

Taseko in recent years has completed extensive technical work that helped de-risk the project significantly. The PTF operated successfully over an 18-month period and provided a valuable opportunity to test operational controls and strategies which will be applied in future commercial operations. In addition, a more sophisticated leaching model has been developed and calibrated to the PTF wellfield performance. This detailed modeling data, along with updated costing, has been used to update assumptions for the ramp up and operation of the commercial wellfield and processing facility.

Additional Funding

In November, Taseko Mines Ltd. announced two additional financing



As one of the lowest-GHG sources of new US copper production, Florence Copper is expected to herald a new era of American mining in support of net-zero. It is one of very few construction-ready, fully permitted copper projects in North America.

transactions, totaling \$100 million for Florence Copper. The company said it has been notified by Taurus Mining Royalty Fund L.P. that it had obtained investment committee approval for a \$50 million royalty, and Societe Generale had received credit approval for a \$50 million senior secured debt facility. Upon closing and satisfaction of conditions precedent, proceeds from these project level financings will be available to Florence Copper to fund the construction and development of its commercial production facility.

“The Taurus royalty and the project loan facility from Societe Generale complement the previously announced commitments from Mitsui and Bank of America,” McDonald said. “A total of \$175 million from these four well-regarded industry participants is a strong endorsement of Florence Copper’s technical merits, attractive economics, and favorable environmental attributes.

The \$50 million Tuarus royalty is for 1.95% of the gross revenue from



During commercial operations, Florence Copper will support ~170 high paying direct jobs on site, as well as an additional 75 indirect jobs in Florence and 480 throughout Pinal County, with an estimated economic contribution of \$3.4 billion to the State of Arizona over the life of the project.

the sale of all copper from Florence Copper for the life of mine. It is payable upon the satisfaction of customary conditions precedent for closing.

The \$50 million facility from Societe Generale is subject to completion of definitive documentation and the satisfaction of conditions precedent. The facility also contains a \$25 million uncommitted accordion feature which can be exercised by the company in the

future to increase its size to \$75 million if needed, subject to additional credit approval at that time. The maturity date of the Florence debt facility will be five years from the date of closing, with no scheduled principal repayments until the maturity date when any outstanding amounts will be repayable. It will have a first lien charge over the assets of Florence and an unsecured guarantee from the company until completion.

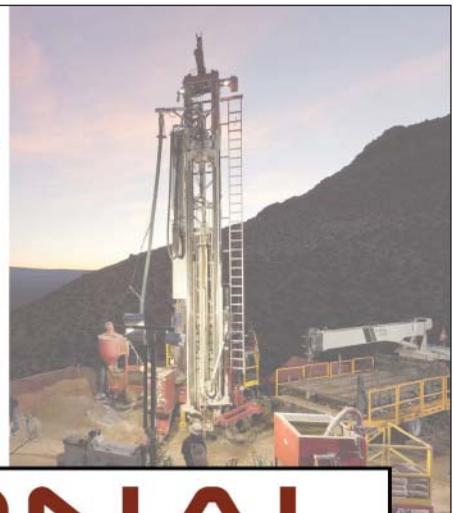


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ASARCO Emphasizes the Importance of Mining

ASARCO has a major focus on educating the public on the importance of mining to their everyday lives and on developing the next generation of miners. Recently, ASARCO participated in the Southern Arizona Construction Career Days in Tucson and the Mines for Limitless Minds Career Fair at the University of Arizona (UofA). The 2-day Construction Career Days annual event provides hands-on experiences to more than 3,500 students from 6th through 12th grades.

The company brought its haul truck simulator to the fair, courtesy of the Mission mine, giving kids the opportunity to explore what it would be like to drive one of these giant machines in a mine. Trainers spoke to students about their experience at the mine and the job opportunities available.

The UofA career fair offered college students the chance to explore high-paying job opportunities and to interface with local employers among not only ASARCO and other mining companies but also with many local businesses that provide highly specialized goods and services to the industry.

ASARCO's Education Committee represents a collaboration of industry partners that have come together to create compelling curricula for schools and career pathways for students to understand their local and global mining career choices. Mining education is a special priority in the communities where ASARCO operates and is the cornerstone of ASARCO's outreach as demonstrated at ASARCO's Mineral Discovery Center south of Tucson.

Since opening its doors in 1997, the ASARCO Mineral Discovery Center has been implementing its founding vision to educate communities on the vital importance of the



Students gather around a haul truck simulator at a career fair. (Photo: ASARCO)

copper mining industry to civilization, to educate students and teachers in earth sciences, and to preserve Arizona's mining history.

On Wednesday through Sunday each week, the center invites guests to take a free self-guided tour of indoor and outdoor exhibits that walk visitors through the copper mining process to the end uses of this metal that is crucial to their everyday lives. Visitors can then join a bus tour of the ASARCO Mission copper mine for a firsthand look at the 2.5-mile long by 1.5-mile wide 1,200-foot-deep open pit mine on 20,000 acres composed of the Mission, Eisenhower, Pima, Mineral Hill, and South San Xavier properties and the nearby North San Xavier mine.

The Discovery Center is suitable for all ages and ASARCO supports Arizona schools by encouraging teachers to bring their students to the center on field trips providing them with free transportation. No visit to

the site would be complete without taking time to peruse the company store for unique, beautiful, and often educational gifts.

Excelsior Provides Update on Mining Activities

Excelsior Mining Corp. is working the mining camp encompassed by the Gunnison copper project, the past producing Johnson Camp copper mine (JCM) and the Strong and Harris exploration projects, all of which are located in Cochise County, Arizona. The Gunnison project is a low cost, environmentally friendly in-situ recovery (ISR) copper extraction project that is permitted to 125 million lb/y of copper cathode production.

"There are relatively few large copper development projects in safe jurisdictions around the world that have our permitting track record and near-term production potential," said Stephen Twyerould, president

and CEO of Excelsior. “[The camp has] the combined potential for more than 150 million lb/y of copper.”

Additional well stimulation modeling has been completed at Gunnison, which supports the results of prior modeling, indicating well stimulation has the potential to greatly improve flow, connectivity and permeability, thereby improving sweep efficiency and gas bubble removal. The company has identified contractors for certain aspects of the well stimulation trials and long-lead item equipment has been acquired or ordered.

Excelsior is taking a broader and more integrated view of the entire mining camp under its control, including the potential for a large, centralized processing facility taking advantage of the recent advances in sulphide leaching technology, like those provided by Nuton LLC, combined with more traditional mining approaches like large open pit mining.

During July 2023, Excelsior entered into an option agreement with Nuton to evaluate the use of its copper heap leaching technologies at JCM. Under the agreement, Excelsior remains the operator and Nuton funds Excelsior’s costs associated with a two-stage work program at JCM. Nuton will provide a \$3 million pre-payment to Excelsior for Stage 1 costs and a payment of \$2 million for an exclusive option to form a joint venture with Excelsior on JCM after the completion of Stage 2.

“With Nuton’s support and technologies, we have the potential to realize the value of the sulphide resources at JCM in a way that is both economical and beneficial to the environment,” Twyerould said. “JCM has the potential to progress towards cash-flow while we continue to develop our other assets, including progressing Gunnison towards well-stimulation trials.”



Wellfield stimulation has the potential to fundamentally change the performance of Excelsior’s ISR wellfield at its Gunnison project. (Photo: Excelsior)

The Stage 1 program involves Excelsior completing diamond drilling, permitting activities, detailed engineering, and project execution planning. Nuton will complete mineralogy, predictive modeling, engineering and other test work. Based on the results of the Stage 1 work program, Nuton has the option to proceed to Stage 2. The Stage 1 work started in August and will take 6 to 9 months to complete.

If Nuton proceeds to Stage 2, it will make a \$5 million payment to Excelsior for the use of existing infrastructure at JCM for the Stage 2 work program. Nuton will also be responsible for funding all of Excelsior’s costs associated with Stage 2. The full Stage 2 work program is anticipated to take up to five years. Revenue from operations will first be used to pay back Stage 2 costs to Nuton and will then be credited to Excelsior’s account.



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L-R, Bryan Seppala, principal advisor economic development and social investment, Resolution Copper; Superior Mayor Mila Beisch; Vicky Peacey, general manager, Resolution Copper; and Superior Town Manager Todd Pryor. (Photo: Resolution)

Resolution Signs Economic Agreement With Superior

The town of Superior, Arizona, and Resolution Copper have signed a Regional Economic Development

(RED) agreement, cementing a collaborative effort to fortify Superior's economic landscape. This historic agreement marks a significant step toward ensuring a prosperous and

resilient future for the community, according to Resolution Copper.

The 3-year, multi-million-dollar agreement is a commitment to fostering economic growth and supporting vital community initiatives. With a focus on multifaceted development, this partnership will bolster essential projects and programs that directly benefit the residents of Superior.

Superior Mayor Mila Beisch expressed her enthusiasm. "This agreement continues our ongoing alignment to achieve a diversified and sustainable economy for a resilient Superior community," she said. "The collaboration with Resolution Copper underscores our dedication to nurturing economic opportunities and enhancing the quality of life for our residents."

Vicky Peacey, president and general manager of Resolution Copper, echoed those sentiments, emphasizing

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ing the transformative impact of this collaboration. “We are thrilled to continue our long-term partnership with Superior to drive economic development and community empowerment,” she said. “This partnership reflects our shared vision for a thriving Superior, focusing on initiatives that support education, workforce development, and the overall well-being of the community.”

The agreement’s focal points encompass a wide array of initiatives, including substantial support for the Superior Multi-Generational Center and the Superior Enterprise Center/Workforce Development Center. These funds will enable community service programming, capital improvements, and robust workforce development programs.

Moreover, the agreement will propel Superior’s annual marketing and tourism program, amplifying efforts to attract visitors and stimulate

economic activity. The infusion of resources will also advance economic development capacity, maintain senior economic advisory services, and fortify an economic development toolkit, further solidifying Superior’s economic foundation.

In a bid to foster educational advancement, the agreement champions the new Superior Lego Robotics program for grades 4-5, fostering innovation and STEM education among the youth. Additionally, it extends support to the Superior Youth Council, empowering young leaders to actively engage and contribute to the town’s growth.

Arizona Gold Begins Leach Test Work on the Philadelphia Project

Arizona Gold & Silver Inc. started initial column leach test work on its Philadelphia gold-silver property, located in Mohave County, Arizona, during December 2023. Arizona

Gold is a young exploration company focused on exploring gold-silver properties in western Arizona and Nevada. The flagship asset is the Philadelphia gold-silver property where the company is drilling an epithermal gold-silver system.

“Column leach test work will be performed on two bulk samples taken from underground workings and from a bench on the surface,” said Greg Hahn, vice president-exploration for Arizona Gold. “The tests are the standard method for determining the amenability of oxide gold and silver bearing material to heap leach methods. This program will establish on a preliminary basis the optimum crush and recovery characteristics for potential heap leaching.”

Additional column test work and agitation leach test work is planned for 2024 on dedicated drill core samples and coarse rejects of reverse circulation (RC) cuttings



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from both the high-grade veins and the stockwork mineralized zones throughout the deposit. This will characterize the leach characteristics and kinetics along the entire strike length of the deposit.

During November, the company published a non-resource technical report on the Philadelphia property. It provides a detailed summary of the property status and all of the historical exploration activity prior to Arizona Gold's tenure, as well as a up-to-date summary of the exploration activities undertaken by Arizona Gold, including a summary of the 141 drill holes completed on the property to date.

The recommended work plan includes 25,000 ft of both RC and core drilling along the strike and dip of the mineralized target identified by drilling to date, mostly confined to "gaps" within the existing drilling database to provide sufficient drilling density

to commission an NI43-101 maiden resource report at the end of the proposed drilling campaign.

Bradda Receives 'Highly Encouraging' Test Results

Bradda Head Lithium Ltd. announced what it described as "highly encouraging" metallurgical test results on samples taken from the Jumbo exploration target at the company's project in the San Domingo District, Arizona. Bradda is positioning itself as a new breed of lithium explorer with exposure to the three types of lithium deposits: brine, hard rock (pegmatites) and sedimentary (clays). The main focus is on the company's sedimentary assets in Arizona, to develop lithium assets with a zero carbon footprint.

The lithium explorer said the test results were better than expected, albeit preliminary, with contractor SGS able to produce a "sell-

able" Li-oxide concentrate product through a dense media separation process (DMS) with a measured head grade of 3.05% from high grade sample material, 1.03% from medium grade and 0.34% from lower grade material.

Metallurgical test work has now paused, pending further samples from the company's newer drilling.

"To produce an 'in spec' sellable gravity concentrate reflecting more than 50% recovery to the concentrate from a sample grading 1.03% Li₂O on first pass test work is simply mouth-watering," Executive Chair Ian Stalker said. "DMS is a standard, low cost, simple process with a small, relatively non-invasive footprint. It's the kind of processing operation that is quick to design and install, and yet can deliver very attractive economic returns.

"We are therefore highly encouraged, and when the next phase of

drilling at San Domingo is complete and sufficient sample material is available, we will revert quickly to SGS with a more detailed test work and study program to further the above objective,” Stalker said.

Intrepid Closes MAN Acquisition

During December 2023, Intrepid Metals Corp. closed its previously announced option to acquire a 100% interest in the MAN Property from Mining and Mineral Opportunity Ltd. (MMO) within its Corral copper project, in Cochise County, Arizona. The Corral copper project area includes 50,000 meters (m) of historical drilling data, with shallow copper and gold mineralization of copper.

The terms of the agreement give Intrepid the option to acquire a 100% interest in the property in return for certain cash and share payments. Intrepid has made the initial \$200,000

cash payment and issued 3.5 million shares to MMO. Intrepid will take over as operator of the property and will be responsible for future exploration work and maintaining the properties in good standing.

“We are very pleased to close this integral acquisition as it completes the consolidation of a 3 km trend of impressive copper and gold mineralization within our larger Corral Copper Project area,” said Ken Brophy, CEO of Intrepid. “We are excited to begin to unlock the value within the district as the previous fragmented land ownership has acted as a barrier to a district scale approach to exploration and development. We now control over 9,500 acres, with 1,800 acres made up of patented mining claims and additional surface rights that host the mineralized trend.”

Located 15 miles east of Tombstone, the Corral copper project is

a district scale advanced exploration and development opportunity. The district has a mining history that dates back to the late 1800s, with several small mines extracting copper from the area in the early 1900s, producing several thousand tons with grades up to 9.2% copper ore. Between 1950 and 2008, various companies explored parts of the district, but the effort was uncoordinated and focused on discrete land positions due to the fragmented ownership.

Intrepid has been able to secure data from various sources which provides a solid foundation in creating geological interpretations and identifying new target areas. By combining modern exploration techniques with historical data and with a clear focus on responsible development, Intrepid said it is confident the Corral copper project can quickly become an advanced exploration

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stage project and move towards feasibility level studies.

Arizona Metals Acquires Additional Private Lands

Arizona Metals Corp. completed the acquisition of a private land parcel totaling 46.4 acres, located 950 meters northeast of its Kay Mine deposit for \$2.5 million. The property was acquired from an arm’s length California-based public company and the transaction included the surface, mineral, and water rights, among other rights and benefits.

“Including the 71 acres of patented land that host our Kay Mine deposit, this acquisition will in-

crease our total holdings of private and patented land to 224 acres,” Arizona Metals CEO Marc Pais said. “The property is contiguous with and adjacent to the 107 acres of patented land (including water rights and wells) the company acquired in January 2021. The additional flat land we are acquiring increases the private land suitable for future mine infrastructure by more than 40% and is in-line with our vision of a minimally-disruptive operation.

“We believe that our Kay Mine project has the potential to become one of Arizona’s newest and highest-grade copper-gold-zinc-silver mines, with the main deposit and

potential for all infrastructure to be located on private land,” Pais said. “This would allow for a small footprint while also providing high-paying jobs to the local community of Black Canyon City.”

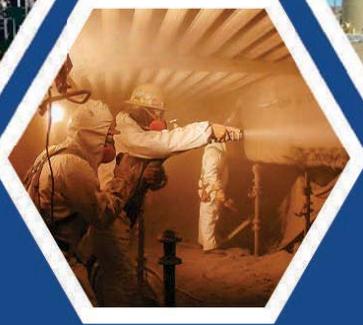
The Kay Mine property is located on a combination of patented and Bureau of Land Management (BLM) claims totaling 1,300 acres that are not subject to any royalties. An historic estimate by Exxon Minerals in 1982 reported a proven and probable reserve of 6.4 million tons at a grade of 2.2% copper, 2.8 g/mt gold, 3.03% zinc, and 55 g/mt silver. *The reserve estimate has not been verified as a current mineral resource.*

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