A summary of the

2022 Jackling Lecture

During the Mining & Exploration (M&E) Division luncheon at the MINEXCHANGE 2022 SME Annual Conference & Expo, Keith Wallace Jr. gave the Jackling Award lecture. His topic was "The Battery Revolution and the Impact on Mining."

Mining companies are making goals to achieve carbon neutrality. This goal requires lowering carbon monoxide emissions. One method of reducing emissions is by replacing internal-combustion engines (ICE) with battery electric vehicles (BEV), and this is an approach many mining companies are currently pursuing.

Wallace noted that the drive for vehicle electrification will have a significant impact on the metals required to produce BEVs, particularly nickel, copper, lithium, cobalt and molybdenum. He pointed out that some estimates have BEVs requiring 3.5 times the copper needed for an ICE and that copper demand may be upwards of 3.7 Mt (4.1 million st) just for this purpose in the next 20 years.

Many Western countries are looking to renewable energy as the means to charge the massive number of BEVs expected in the next decade. However, renewable energy sources, such as wind and solar, also require significant minerals and metals. Wind power projections could result in an additional demand on copper of 5.5 Mt (6.1 million st) in the next decade. Combine this with metal needs for charging stations and large energy storage facilities that will feed power grids, and the quantity of metals required could easily outstrip current production. This is particularly true when it often takes more than 10 years to develop a mine from exploration to production.

He pointed out that the drive to develop large battery storage facilities is just beginning. California has the world's largest facility in Moss Landing using Tesla Megapack batteries. However, the packs still need to be charged. Wallace mentioned that this is a challenge for going entirely to green energy. In 2020, California, one of the states on the forefront of going carbonless for energy needs, still had 48 percent of its power generated from natural gas; wind and solar accounted for 21 percent and the state imported 30 percent of its power from other states. This shows the challenges of going green, and the impact on metal demand as green energy is pursued.

Mining was one of the first industries to investigate BEVs, even before the drive to carbon neutrality. The impetus behind this drive was ventilation and heat control in underground mines. Deep, hot mines are challenged to provide acceptable working conditions at depth. A large impact on these types of mines is the use of diesel equipment, and its associated challenges with emissions, such as carbon monoxide, nitrogen oxide and diesel particulate matter. By converting to BEVs these pollutants are eliminated. In addition, heat from a BEV is significantly less than that of an ICE.

Mining & Exploration Division past chair Matt Blattman (l) with Jackling Award winner Keith Wallace Jr.

For underground mining, two types of battery charging systems are considered. The first is battery swapping where batteries are physically removed from the machine and placed on a charging system and a fully charged battery is placed on the machine. The other is a fast-charging battery system where the on-board battery is charged in 15 to 30 minutes. Battery swapping systems have a four- to six-hour operational time, plus 15 minutes to swap batteries, while fast-charging systems typically have a two- to three-hour operation time. Fast-charging systems require high-current electrical systems internal to the mine.

Numerous engineering studies have been performed comparing the benefits and disadvantages of swapping diesel to battery electric mining machines. Some of the benefits are elimination of diesel engine exhaust, significant reductions in heat and reductions in ventilation demand, resulting in lower capital and operating costs.

While these benefits are significant, there are risks a mining company must consider when implementing BEVs. These risks include, undersizing the overall ventilation system, less flexible operation, BEV fires and limits to haulage distances with BEVs for long ramps. Engineers must determine optimal locations for battery charging or swapping stations and plan production around battery operational limits. The skill set required to maintain BEVs is also different than for a typical diesel operation. Electricians and mechanics familiar with BEVs will be required, but are not yet common in the industry.

These risks need to be analyzed in a study that includes long-range ventilation and mine planning, thermal modeling,

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SME and AIPG enter into partnership

focused on exploration geology

The Society for Mining, Metallurgy & Exploration (SME) and The American Institute of Professional Geologists (AIPG) are pleased to announce an official partnership between their two organizations. This alliance will enhance professional collaboration and participation in joint opportunities to promote geology and exploration to benefit members of both organizations.

Geology plays an important role throughout the mine life cycle, and many mining professionals are also professional geologists.

"This relationship creates an excellent opportunity for geoscience professionals from SME and AIPG to collaborate in developing stronger programming on economic geology topics, benefiting the members of both groups," said SME President Ronald L. Parratt. "Members will notice an increase in annual-meeting programming, as well as potential special symposia, seminars and field trips related to the important topic of economic geology. We are excited about this partnership and look forward to working with AIPG."

"I am very pleased to see the formalization of the strong relationship that our organizations had already established through many years of members being active in both AIPG and SME, and the common interests shared on an organizational level, by AIPG and SME," said AIPG President Matthew Rhoades. "Geologists are essential in mining, and AIPG believes that this formal agreement will benefit our members who are working in the mining industry, as well as in a wide variety of other workplaces."

SME and AIPG will work collaboratively, on a non-exclusive basis, to promote technical innovation within the exploration geology and mining industries between their respective members.

Founded in 1963, AIPG is the largest association dedicated to promoting geology as a profession. It presently has more than 5,000 members in the United States and abroad, organized into 35 regional sections. The institute adheres to the principles of professional responsibility and public service and is the only international organization that certifies the competence and ethical conduct of geological scientists in all branches of the science with members employed in industry, government and academia.

SME brings together the mining and mineral industry's brightest and most dedicated professionals. More than 13,000 global members advance their careers with the world-class technical resources, educational programs, networking opportunities and professional development tools from SME. SME members are focused on sharing best practices for safety, environmental stewardship and moving mining forward. ■

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phased ventilation models, airway size sensitivity analyses, and fire/transient time modeling. The risk study also needs to consider if the ventilation system will have capacity for the additional airflow requirements if the mine converts back to using some diesel machines.

One significant risk factor is a BEV fire. Battery fires can arise from external damage, overcharging, internal short circuiting and other factors. A BEV fire will expose the underground to gases that are not found in a diesel equipment fire. In fact, more than 100 toxic gases can be released by lithium-ion batteries, including hydrogen fluoride (HF), hydrogen cyanide (HCN), carbon monoxide (CO) and phosphorous oxyfluoride (POF_3).

Lithium-ion fires can be difficult to extinguish as the fire may be confined to the battery pack. Fighting the fire in the enclosed pack is difficult, it may require large quantities of suppressant and may reignite if not cooled sufficiently. CO_2 or chemical extinguishers may suppress the fire, but may not cool the battery pack, while water sprays are effective at cooling but may trigger more electrical faults and react with lithium to release hydrogen gas. These are important risks to study when implementing BEVs on a project.

The risk assessment should include, knowing the types of BEV vehicles used on the project, having a vehicle tracking system, knowing where BEV charging stations and battery storage locations are along with the quantity stored at each location, proper training of mining, electrical and mechanical trade personnel on BEV operation, and having a robust emergency response team familiar with BEV firefighting.

BEV charging stations and battery storage facilities will ideally be located near an exhaust. These locations need to include gas sensors, fire doors and fire suppression systems. It is important that sufficient water be available in the facilities to fight a battery fire. This same capability should be included where the equipment will regularly park. Mine operations will need to ensure proper handling and removal of excess batteries where all old batteries are immediately removed from the mine. Finally, a full understanding of the ventilation system is required so that in the event of a fire, mine rescue teams can access the area in an effective manner.

Wallace summarized his presentation by stating the drive to battery equipment will have a significant impact on metals, and it is feasible that demand for base metals could exceed current supply, resulting in a super cycle for certain minerals. It is projected that the use of BEVs for mining applications will continue to increase as more companies seek carbon neutrality. However, careful planning is required with BEVs to ensure operational flexibility, location of charging stations, and training of personnel in operating and maintaining the equipment. Finally, a detailed risk assessment needs to be performed on best operating procedures with BEVs, BEV firefighting and emergency egress planning. ■