SME Society for Mining, Metallurgy & Exploration®

MINEXCHANGE

2026 SME ANNUAL CONFERENCE & EXPO

FEBRUARY 22-25, 2026

SALT LAKE CITY, UTAH

TECHNICAL PROGRAM

TECHNICAL SESSIONS

Technical program as of December 19, 2025. For the most current information please refer to the conference app.

Monday, February 23 Afternoon

DREYER LECTURE

150D-E

Chairs: ***D. Bryan***
W. Wilkinson*, Phoenix*

1:30 pm

Introductions

1:35 pm

What Role Does Field Geology Play in an AI-driven Mineral Exploration World?

R. Leveille; Dreyer Award Lecturer, Mesa, AZ

Applying machine-learning pattern recognition and decision making techniques to mineral exploration has surged in the last decade. Well-funded private and public companies have been incepted with the goal of using AI to area-selection, prospect generation and drill hole targeting. While valuable for sorting through large volumes of data, too much reliance on these tools may deceive the user. The experienced field geologist has the advantage of having explored in, over and around many deposits and many "not deposits". This experience helps fine tune the geologist's ability to avoid common cognitive biases that can subvert human decision making while allowing for full play of what we might call our inherent exploration "spidey sense". This is the intuitive faculty that represents the distillation of an experienced explorer's lifetime of observations, successes and failures. Ideally, working in concert with powerful computer-based data analysis and machine learning techniques and other relevant earth science and AI experts, a seasoned field geologist's contributions can still make mineral exploration much more effective and efficient.

Monday, February 23 Afternoon

BULK MATERIAL HANDLING: ENGINEERING DESIGN, SAFETY AND OPERATION

155A

Chair: ***T. Pinto****, Astec*

2:00 pm

Introductions

2:05 pm

From Plugged to Productive: A Unified Approach to Transfer Chute Challenges

C. Hartford[1] and S. Maldonado[2]; [1]Jenike & Johanson, San Luis Obispo, CA and [2]Freeport McMoRan, Morenci, AZ

In today's dynamic mining environment, frequent turnover among engineering personnel makes knowledge transfer at both the mine and plant increasingly difficult – posing serious risks to plant reliability and maintenance. To reduce these risks, effective training and a systematic approach to projects are essential. This presentation will share a case study in which a multidisciplinary team was assembled to resolve persistent transfer chute plugging. The team included members from maintenance, operations, engineering, equipment vendors, and industry experts, all working together to reach a unified solution. By measuring material flow properties and employing calibrated Discrete Element Modeling (DEM), the team was able to design a robust and reliable solution that significantly improved performance.

2:25 pm

Leveraging 3D Laser Scanning and Mass Flow Engineering in Coal Facilities

N. Svoboda; Stahura Conveyor Products, Butler, PA

Upgrading a coal facility demands accuracy, speed, and safety: especially when working within tight outage windows. At Cleveland-Cliffs Pinnacle underground operation, conventional transfer points struggled with large longwall rock fragments, heavy spillage, and persistent dust. Our team used high-resolution 3D laser scanning to capture exact existing conditions and drive advanced mass flow engineering. Through precise 3D modeling and Discrete Element Method (DEM) flow simulations, we replaced conventional designs with mass flow chutes incorporating throughput sealing and dust control. Four heads were completed on time, on budget, and with measurable improvements in flow, reduced spillage, and minimized dust generation.

2:45 pm

Ensuring Air Cannon Efficiency for Optimal Plant Operations

S. Mercer; Martin Engineering, Neponset, IL

Air cannons are essential for maintaining plant efficiency and safety, but traditional manual checks are unreliable due to ambient noise and accessibility issues. While air gauges offer better diagnostics, they can't assess discharge efficiency, which depends on tank size, valve type, air pressure, and nozzle type. Since discharges occur in milliseconds, partial obstructions are hard to detect without advanced tools. The Martin® Air Cannon Intelligence System addresses this by using a Pressure Transducer, Sensor Node, and Cellular Gateway to monitor and alert for anomalies, track tank and line pressure, and measure discharge efficiency—ensuring optimal performance and reducing operational risks.

3:05 pm

Silo Production

D. Blauser; Marietta Silos, LLC, Marietta, OH

This presentation explores key aspects of silo design and construction, with a focus on understanding various silo flow patterns, including funnel flow, mass flow, fluidized flow, and expanded flow. It highlights the importance of avoiding asymmetric flow, which can lead to structural and operational issues. The discussion includes comparisons between construction methods, particularly concrete versus steel silos, and examines the critical design considerations for both silos and stacking tubes. Special attention is given to challenges associated with storing fly ash and other industrial by-products. The presentation reviews the ACI 313 design code and outlines the key differences between industrial and grain silo design. Guidance is provided on how to effectively approach a new silo construction project, including pitfalls to avoid and best practices for scheduling design and construction activities.

3:25 pm

Waterless (and Low Water) Dust Management in Mining Applications

G. McDonald; Salford University, UK, Vancouver, BC, Canada

Dust is an enemy of mining operations. At best it leads to complaints and early equipment failures, at worst it can lead to explosion hazards, staff illness and regulatory issues. Traditional dust control methods rely on water sprays, but with water becoming a constrained resource this presentation will look at alternate methods of dust management and control used in other areas and how they can benefit the mining industry. From reducing dust generation to gentle handling through material transfers to stockpile protection to vacuum dust extraction there are a variety of methods that can reduce dust and displace the use of water for dust control. The presentation will discuss the pro's and cons of different methodologies as well as capital and operating costs. With more than 30 years of bulk handling experience the presenter has addressed dust issues in industries around the globe from mining to food production.

Monday, February 23 Afternoon

COAL & ENERGY: BEST OF GROUND CONTROL

151 D-F

Chairs: ***Z. Agioutantis****, University of Kentucky, Lexington, KY*
R. Mitra*, South Dakota Mines, Rapid City, SD*

2:00 pm

Introductions

2:05 pm

Conceptual Approach for Long Term Pillar Stability

G. Hasenfus; Barr Engineering, Salt Lake City, UT

Significant advancements in coal pillar design methodologies disseminated over 44 years of the ICGCM, have benefited present-day active coal mine safety and mine design optimization in countless ways. Despite such advancements, however, long-term pillar stability, particularly for abandoned mines, is still somewhat of an enigma, mostly addressed by conservative stability factors to account for unknowns. A conceptual approach and methodology will be discussed whereby long-term pillar stability can be assessed as pillar periphery rib failure, whether due to soft floor foundation failure or strength degradation due to weathering mechanisms. The concept will be supported by past research and observations by this and other authors, with empirical validation based on pillar failures and subsidence occurrences.

2:25 pm

Using LaModel for Analyzing Stress Distribution in Benched Areas for Possible Massive Stone Pillar Collapse

D. Tuncay[1], Z. Agioutantis[2] and A. Elibol[2]; [1]University of Kentucky, Lexington, KY and [2]WVU, Morgantown, WV

In recent years, there has been an increase in massive pillar collapse occurrences in limestone mines in the U.S. The areas with slender or benched pillars have been of concern in limestone mines where the most common mining method is the room and pillar method. Due to the lower width-to-height ratios of the benched pillars and further decreasing pillar widths due to spalling, these areas have been identified as unstable. This study aims to analyze a case study mine with benched areas using the LaModel software, a commonly used software for modeling underground coal mines. The empirical pillar strength equation suggested by the S-Pillar design guidelines is implemented into LaModel and applied to the benched area of a case study mine. This presentation will discuss the failure of a single pillar and the associated load transfers, and the pillar degradation due to spalling (decrease in pillar width), and how the stability factors are affected. The effect of the lamination thickness parameter, which governs the load transfer and stress distributions in LaModel was also investigated.

2:45 pm

Subsidence Hazard Assessment over an Abandoned Multi-Seam Coal Mine in Western Kentucky: A Case Study

R. Ray, A. Pfaff, B. Haugen, C. McCannon, J. Morgan and M. Ricci; RESPEC, Lexington, KY

Accurate prediction and management of surface subsidence over historical coal mines is essential for mitigating risks to infrastructure, ensuring public safety, and protecting the environment. Many historical mines, particularly those abandoned before modern record-keeping practices, lack detailed maps, geological data, or records of mining methods and site conditions, and are unable to be safely accessed. This study presents a phased subsidence hazard assessment for a candidate power generation facility site in Madisonville, Kentucky, which overlies the historically mined WKY 9 and WKY 11 coal seams. The investigation was conducted in two phases: Phase 1 encompassed historical data reviews, site inspections, and coal pillar stability analyses using the Analysis of Coal Pillar Stability (ACPS) program. Phase 2 involved core drilling, laboratory testing, and advanced numerical modeling using FLAC3D to assess ground stability and predict potential subsidence magnitudes.

3:05 pm

26-047

Physical Modeling of Complex Coal Rib Brow Failure and Its Applicability to Numerical Modeling

C. Mitchell, D. Guner, A. Kirmaci and T. Sherizadeh; MS&T, Rolla, MO

Brow hazards are a significant concern in coal mine ribs and form when weak coal sloughs out of a rib face and exposes an overhanging block of more competent rock or coal. Of 36 rib failure fatalities in the last two decades, 36% resulted from rib brow failures. The research team at Missouri S&T worked to enhance the current CPRR system and include the potential for these brow hazards. We employed physical modeling methods to build a scaled model from critical brow cases observed in the field. The dimensions and properties of the models were scaled down by 14.4 times from the field cases. The results of the physical modeling efforts were used to assist in calibrating distinct element numerical models vital to understanding brow formation and failure mechanisms. Subsequently, three physical models were created and tested to provide data on an otherwise impossible-to-capture event at the field scale.

3:25 pm

Mining Under Flooded Mine Workings and Other Sources of Groundwater

Z. Wedding and Z. Agioutantis; University of Kentucky, Lexington, KY

The coal mining industry in the United States has an extensive history of multiple seam mining and mining underneath bodies of water. Historically, mining under bodies of water has been primarily focused on the effects of ground movements from full panel extraction beneath surface bodies of water and the height of complete groundwater drainage. Full panel extraction under such conditions can present hazards such as inundation of mine workings, and disturbance of groundwater aquifers. These challenges are also present in mines that are operating below flooded mines. Previous mining in the upper seam generates stresses that may produce cracks in the surrounding (upper and lower) rock strata. Development or full extraction mining under a previously mined seam will generate additional stress in the interburden in which the cracks can become pathways for water to inundate the lower seam. This paper presents a literature review of mining under bodies of water with a focus on multiple seam mining. Case studies from the literature and the factors leading to success or failure will be discussed.

Monday, February 23
Afternoon

COAL & ENERGY: CORE - CM/RARE EARTHS

151G

Chairs: ***A. Kumar****, The Pennsylvania State University - University Park Campus, State College, PA*
S. Han*, The Pennsylvania State University, University Park, PA*

2:00 pm

Introductions

2:05 pm

Characterization of Combustion Residuals from High-Ash-Anthracite-Fired Power Plants

D. Levitan, A. Kolker and B. Valentine; U.S. Geological Survey, Reston, VA

In evaluating rare earth element (REE) occurrences in coal byproducts, we examined combustion residuals (fly ash) from power plants fueled by high-ash anthracite or gangue in Vietnam and the United States. Coal with a high ash content (>10-20%) often requires beneficiation to optimize efficiency in power generation. However, circulating fluidized-bed (CFB) boilers can combust high-ash coal efficiently and may be installed to burn coal that would be considered refuse elsewhere. CFB plants use lower temperatures (~900-950°C) than conventional pulverized coal plants (≥1300°C), resulting in fly ash with different mineralogical compositions. In particular, clay minerals (e.g., illite, kaolinite) do not reach high enough temperatures to convert into aluminosilicate glass or mullite. Clays persisted in the CFB fly ashes, whereas the fly ash from a conventional plant adjacent to one CFB plant consisted mainly of quartz, glass cenospheres, and mullite. Previous studies have shown that these higher-temperature forms commonly host REEs in conventionally produced fly ash. REE extraction from fly ash can be difficult but may be more feasible for the less-recalcitrant minerals in CFB fly ash.

2:25 pm

Computed Tomography Analysis of Microwave-Driven Vanadium Extraction in Marcellus Shale

T. Paronish[2], A. Abedin[2], C. Henkel[2], S. Isom[3], D. Crandall[3], C. Wildfire[1] and M. Gill[2]; [1]West Virginia University, Westover, WV; [2]NETL Support Contractor, Morgantown, WV and [3]National Energy Technology Laboratory, Morgantown, WV

The National Energy Technology Laboratory's Reaction Engineering Team has developed a novel technique utilizing microwaves to increase the extractability of vanadium in shales. This study examines the alteration of Marcellus Shale samples with varying clay mineralogy, total organic carbon, and pyrite framboid size and distribution. By utilizing computed tomography images of samples before and after the experiment, we can quantify structural changes in volume and surface area in the whole volume as well as particle-to-particle. Primary results show a significant increase in vanadium extraction and surface area influences due to variable shale lithology.

2:45 pm

Exposing 3D Geologic Controls on REE Distribution in Carbonaceous Sediments at the Brook Mine

A. Moyes; Ramaco Resources, Sheridan, WY

The Brook Mine in the Powder River Basin hosts the first permitted mining operation in the United States in 70 years targeting rare earth elements (REEs) from unconventional carbonaceous sedimentary systems. Due to the lack of natural outcrop exposures in the area, early exploration and resource modeling efforts relied on core drilling, lithological logging, and wireline data. However, the recent development of an open pit has provided a unique opportunity to directly observe and sample a high-resolution, three-dimensional exposure of a key ore zone, the stratigraphic transition between the Dietz and Monarch coal seams. Eight lithologic transects were sampled and analyzed by ICP-MS, then correlated to nearby wireline logs. Paired with high-resolution imagery and petrophysics, this reveals lateral and vertical grade variability and key geologic variables that appear to control enrichment, such as lithotype, ash content, mineralogy, and sedimentary strucutres. These insights improve genetic understanding, resource modeling, and selective mining in unconventional REE systems and offer a template for similar sediment-hosted critical mineral deposits.

3:05 pm

Rare Earths, Graphite, and Other Critical Minerals Recovery from a Bituminous Coal Source

H. Khalid, R. Honaker, B. Ji and J. Groppo; University of Kentucky, Lexington, KY

A processing approach is being evaluated at bench and pilot scale for the recovery of rare earth elements (REEs), battery-grade graphite, and other critical elements from coal-derived tailings. Bituminous coal from the Fire Clay seam was collected from the middling product stream of a coal preparation plant. In preparation for pilot plant studies, bench top tests were performed to assess the ability to produce 5% ash yield coal for graphite production while generating a mineral matter stream enriched in critical metals. After concentrating the mineral matter, roasting and leaching test were performed to identify conditions that maximizes critical element recovery, particularly rare earth elements. The presentation will summarize the findings and discuss plans for the pilot plant test program.

3:25 pm

Humidity Cell Testing of Coal Refuse: Kinetics of Rare Earth Element Release Under Simulated Weathering

J. Hartman, N. Becker and A. Noble; Virginia Tech, Blacksburg, VA

Over the last decade, research efforts have evaluated coal refuse as a potential source of rare earth elements (REEs). Several groups have developed technically viable processing pathways; however, the relatively low REE concentrations and finely dispersed mineral occurrences create prohibitive economic and operational challenges. One way to mitigate these issues is to leverage autogenous processes, such as natural weathering and acid generation, to offset or enhance some of the initial REE extraction steps. In this study, we used humidity cell tests to simulate the natural weathering of coal refuse while observing the kinetic release of REEs and other CMs. Tests were performed over 26 weeks and included 16 samples from the Illinois and Appalachian coal basins. Of the samples tested, five produced measurable REE leaching, with leachates assaying up to 30 ppm. The data also showed a distinct kinetic trend with heavy REEs, particularly Y, leaching in earlier cycles, while light REEs leached more slowly, possibly indicating distinct host mineralogy of the REEs. This presentation will discuss the experimental data and the implications for improved extraction and recovery processes.

3:45 pm

Initial Geochemical and Mineralogical Evaluation of Coal Ash and Refuse Samples for Critical Mineral Recovery in Northern Appalachia

C. Subasinghe, C. Caswell, T. Khosbayar and B. Arnold; The Pennsylvania State University, University Park, PA

Samples of coal ash and coal refuse collected across Pennsylvania during the US DOE CANARY CORE-CM project were selected for their higher rare earth element content to further evaluate their potential as unconventional critical mineral resources. Major and trace elements were quantified using ICP-MS and ICP-AES, and X-ray diffraction (XRD) revealed dominant phases including pyrite, quartz, gypsum, kaolinite, and muscovite. Simple leaching tests as well as NaOH roasting followed by water or acid leaching were employed to assess extractability. Results suggest that efficient extraction is feasible if critical elements are sufficiently enriched, potentially enabling recovery without extensive beneficiation.

Monday, February 23 Afternoon

COAL & ENERGY: LONGWALL OPERATIONS & PROJECTS

Sponsored by BARR

151 A-C

Chairs: ***E. Howe****, Alliance Coal, LLC - Tunnel Ridge Mine, Moundsville, WV*
S. Zeeh*, Oak Grove*

2:00 pm

Introductions

2:05 pm

Estimating Groundwater Inflow for Longwall Mines in Multiple Seam Mining Scenarios Using Numerical Modeling

Z. Wedding and Z. Agioutantis; University of Kentucky, Lexington, KY

Longwall mining induces caving and bedding separation in the overlying strata, creating pathways for groundwater to flow into the mine. Empirical equations have been developed to estimate the extent of fracturing and connected pathways above longwall panels. Knowing the vertical extent of these pathways is crucial for accurately estimating groundwater inflow, especially in scenarios involving multiple seam mining, as these empirical equations produce significantly different heights of fracturing. This presentation will discuss the factors for the development and calibration of a numerical model used for estimating groundwater inflow. These factors include estimating the extent of the caving and fracture zones and mining-induced hydraulic conductivity enhancement.

2:25 pm

Forged Through Fire: The Rebirth of Allegheny Metallurgical's Longwall Operations

J. Bobbera; Allegheny Metallurgical, Volga, WV

Allegheny Metallurgical is an underground longwall mining operator based in north-central West Virginia. In June 2024, the operation faced a significant setback when an underground fire resulted in the loss of its inaugural longwall panel and associated equipment. Over the past 18 months, the company has worked safely and diligently to redevelop its underground workings, procure new longwall equipment, and implement key operational improvements. These efforts have positioned Allegheny Metallurgical to reemerge as a world-class mining operation for years to come.

2:45 pm

Jennchem - Discover the Advancements in Urea Silicate Foam Technology

T. Kurutz and G. Swartz; Jennchem, Washington, PA

While urea silicate foams have been utilized for many years, recent industry-wide initiatives to improve mine safety and enhance efficiency in backfilling and void-filling operations have brought these materials back into focus. In response to these evolving demands, Jennchem has developed two advanced formulations: Ultra X and Ultra S. This presentation will explore the key distinctions between Ultra X and Ultra S, highlighting how each product can support various operational needs. We invite you to join us as we address current challenges in the field, demonstrate how these innovative solutions can improve your operations, and provide insight into some of the most advanced urea silicate foams available in the industry today.

3:05 pm

The Evolution of Longwall Systems at Warrior Met Coal

P. Saunders; Warrior Met Coal, Vestavia, AL

Over the last nine (9) years, Warrior has upgraded the longwall (LW) fleet with a progression of technological and engineering improvements, along with standardization ot the complete LW systems. The initial upgrades to the LW fleet started with the addition of Controlled Start Transmissions (CSTs) to improve face chain performance and protection. Next was the addition of Memory Cut followed by Advanced Shearer Automation (ASA). In 2019, working with Komatsu engineers, Warrior developed a Powered Roof Support (PRS) design that matches conditions that will be encountered over the next 40+ years across all Warrior Mines. This design and an upgrade to the shearers facilitated the next improvement, the use of Landmark. The improved PRS design, use of automation, and improved engineering of panels will continue to allow Warrior to operate the three (3) current Longwalls and an additional Longwall that will be utilized at Blue Creek. The standard design used by Warrior at all locations allows for equipment to be used at multiple locations, so that several "spare" faces can be used to minimize longwall moves by having systems set up in advance to have zero (0) day moves.

3:25 pm

Multi-Pronged Methane Management Approach at an Active Longwall Mine

P. Pelley; Iron Senergy, Waynesburg, PA

This presentation presents a comprehensive methane abatement strategy deployed at an active longwall coal mining operation that integrates multiple technologies to capture and utilize or destroy methane streams. The project employs high-temperature flaring systems to manage gas assets from low-volume boreholes, ensuring destruction of methane that would otherwise be vented. A regenerative thermal oxidizer (RTO) has been installed to target low-concentration VAM, enabling the destruction of dilute methane exhausted through the mine's ventilation system. A low-pressure gathering network consolidates GVB from surface gob vent boreholes, enabling controlled flaring or beneficial use. Additionally, the deployment of pre-drainage systems—comprising surface and in-seam horizontal wells—reduces in situ gas content in coal seams prior to mining, minimizing future VAM emissions and improving underground safety conditions. Collectively, these integrated systems offer a model for coal mines to reduce methane emissions, increase gas utilization, generate carbon offset credits, and enhance mine safety. The presentation outline the outcomes of this multi-pronged methane management approach.

Monday, February 23 Afternoon

EDUCATION: UNIVERSITY AND INDUSTRY EDUCATION COLLABORATION AND NEEDS

155C

Chairs: ***J. Kellar****, SD School of Mines and Technology, Rapid City, SD*
R. Mitra*, South Dakota Mines, Rapid City, SD*

2:00 pm

Introductions

2:05 pm

Department Heads Update

K. Luxbacher; University of Arizona, Tuscon, AZ

Update on the current state of US mining schools.

2:25 pm

Mining Engineering at Tennessee State University: Program Development and Integration with Tennessee's Mining Industry

K. Brown Requist and A. Spears; Tennessee State University, Nashville, TN

To fill the need for mining engineering talent across the United States, Tennessee State University is starting a comprehensive mining engineering minor program and plans to start a Bachelor of Science in Mining Engineering program in 2028. TSU's mining engineering program is the only mining engineering program in the state of Tennessee as well as the first mining engineering program at an HBCU. With a focus on developing a new program designed to provide home-grown mining engineers for Tennessee's mining industry, TSU is partnering closely with Tennessee-based mining operations. This talk focuses on TSU's collaboration with Tennessee's mining operations through a variety of advisory, educational, and research partnerships.

2:45 pm

MiEX: A Transformative Minerals Industry Talent Pipeline Solution - Engaging the Next Generation of Industry Professionals

B. Howard and R. Ramsden; Rio Tinto, Perth, WA, Australia

The Minerals Industry Experience Program (MiEX) was developed to address several long-standing issues in Australia's minerals industry talent pipeline; a dwindling supply of minerals/mining graduates, the acute decline of mining schools, lack of diversity and prevailing negative industry perceptions: all challenges individual companies alone cannot solve. A collaboration led by the Minerals Council of Australia (MCA), MiEX explores the minerals industry value chain, revealing its contributions to society, technical complexities, innovations and challenges, as well as diverse career paths. Over four weeks, first year university STEM students hear from technical industry professionals, engage in panel discussions and interactive team-based activities, also gaining practical insights and deeper understanding of operations through on-site exposure and experiences. The objective is to encourage students to consider a minerals/mining education pathway and become part of the industry talent pipeline. MiEX is now being explored for international deployment to support global minerals workforce needs.

3:05 pm

Maximizing the Use of Technology Tools in Mining Training and Education

S. Larsen; FLSmidth, Smithfield, UT

Mining companies are struggling to attract young technical talent to the industry; indeed, the larger audience of SME has been concerned with problem in recent months. And, once hired, there remains an urgent need to train the newly hired talent quickly and powerfully. Though time on real equipment is crucial for the needed skills training, it is often very difficult to give technicians access to functioning equipment to learn, practice, and be assessed. Many training programs utilize learning aids such as virtual reality to assist learners in assimilating the technical information needed to be successful in operations and maintenance of large mining equipment. But new research shows that using these aids doesn't necessarily aid retention; targeted and strategic learning activities with media technology must be used to yield the greatest learning results. This presentation will highlight several proven ideas for how to successfully implement training strategy around virtual reallity, augmented reality, and the use of 3D models. Shayne Larsen, Ph.D., Doctorate of Education (focus on Adult learning Theory), Global Director of Training and Certification, FLSmidth

3:25 pm

Immersive Safety: Integrating XR/VR for Lockout Tagout Education in Mining

N. Risso[1], J. He[1], B. Czerkawski[1] and A. Schneider[2]; [1]University of Arizona, Tucson, AZ and [2]Yoy Simulators, Vina del Mar, Chile

The rising global demand for critical minerals has increased the need for a skilled, safety-conscious workforce. This workforce spans skills and expertise across different disciplines, but safety training remains a universal priority. Research shows that integrating safety education early leads to better outcomes. Immersive technologies like Extended and Virtual Reality (XR/VR) offer realistic, interactive training in safe environments, allowing to rebuild skilled labor for critical minerals. This project discusses the design, implementation, and evaluation of XR-based methods for teaching lockout/tagout procedures within mining and engineering curriculum. Results highlight improved safety training along with the integration of commercially available training tools.

3:45 pm

U.S. Department of Energy: Establishing the Domestic Workforce Needed to Restore America's Mineral Dominance

C. Woodall; U.S. Department of Energy, Washington, DC

The U.S. Government has expressed a renewed interest in the mining sector with the goal of restoring America's mineral dominance. To achieve this goal, there is a clear need to chart a path towards vastly expanding the domestic supply of a highly-skilled workforce in the critical mineral supply chain and, more broadly, the entire energy sector. The U.S. Department of Energy (DOE) has taken recommendations from its 21st Century Energy Workforce Advisory Board and has set the goal of developing an Energy Workforce Strategy. A pivotal component is the DOE's strategy to develop a Workforce Plan for the Critical Mineral & Materials (CMM) Supply Chain. While the DOE has several existing programs that address different portions of the CMM workforce pipeline, it has identified gaps to be addressed with new initiatives. Attend this session to learn about existing programs and upcoming initiatives and to provide feedback on additional areas of need to grow the domestic CMM workforce.

4:05 pm

What a Ride: Mining Industry to University, a Decade of Experience

S. Rosenthal; Montana Technological University, Butte, MT

Ten years ago I shared my initial journey from industry to academia. This paper provides an update of my academic experience and ongoing industry collaboration during the last 10 years. Sharing my journey and challenges is intended to entice mining professionals in industry to join the ranks of academia. All mining engineering programs continue to see a need for qualified faculty, especially those with industry experience.

4:25 pm

Empowering the Future of Mining Through Local Professional Society Partnerships: A Utah Based Model for Academic–Industry Engagement

C. Miller; Barr Engineering Co., Heber City, UT

The future of mining depends on meaningful collaboration between academia, industry, and professional societies. This presentation highlights the impactful partnerships between the University of Utah and the Utah sections of the Society for Mining, Metallurgy & Exploration (SME) and Women in Mining (WIM). These organizations play a vital role in fostering innovation, knowledge exchange, and professional development within the region. By showcasing current initiatives and offering actionable strategies, this talk aims to inspire similar collaborations nationwide and provide ideas for enhancing existing efforts—ultimately strengthening the role of professional societies in shaping a sustainable mining workforce.

Monday, February 23 Afternoon

ENVIRONMENTAL: ADTI: ADVANCES AND NEW INSIGHTS IN ENVIRONMENTAL GEOCHEMISTRY

Sponsored by ARCADIS

255A

Chairs: ***P. Nolan****, WSP, Novi, MI*
L. Kirk*, Enviromin Inc, Bozeman, MT*

2:00 pm

Introductions

2:05 pm

Acid Generation at Coal Combustion Residual Facilities

C. Mayer, P. Nolan and R. Verburg; WSP, Novi, MI

While mine wastes such as waste rock or tailings are widely recognized globally as a potential source of acid rock drainage (ARD), legacy mining products designated as industrial wastes can also be acid forming. Across the United States, localized acidification is noted at current and former coal power plant sites. These sites may host large amounts of potentially acid forming products, such as in pyrite disposal areas or Coal Combustion Residual (CCR) units. In the case examples presented here, groundwater acidification has been observed at CCR facilities, causing elevated concentrations of metalloids/metals (e.g., arsenic, beryllium, cadmium, cobalt, or nickel). While CCR leachate or pondwater is generally circum-neutral or alkaline, acidification processes may occur locally, including the oxidation of residual pyrite within the disposal facility or processes promoted by remedial activities, such as sulfate reduction and re-oxidation or precipitation of iron. Thus, the risk of acidification of groundwater resources at CCR sites requires evaluation, despite the generally neutral characteristics of the CCRs themselves.

2:25 pm

Microbial Dynamics in Kinetic Tests of Sulfide-Bearing Rock Over Two Years of Operation

M. Best[1], D. Jones[1], Z. Wenz[2], S. Koski[2] and A. Gehn[2]; [1]New Mexico Institute of Mining and Technology, Socorro, NM and [2]Minnesota Department of Natural Resources, St. Paul, MN

Microorganisms have long been recognized as powerful catalysts for sulfide mineral oxidation, and have previously been found to contribute to mineral weathering in long-term kinetic tests. Changes in temperature, chemistry, or moisture conditions within the kinetic test can alter the microbial community structure and composition, which may affect mineral oxidation rates within the test cell. Here we report new DNA- and RNA-based analyses of microbial communities in laboratory kinetic tests and field piles of pyrite-bearing Ely Greenstone to evaluate the microbial community structure and composition across different treatments to better understand the microbial contributions to sulfide mineral weathering and implications for kinetic test performance.

2:45 pm

pXRF to the Rescue: A Rapid Field Method for Acid Base Accounting

S. Bronec and D. Tooke; GSI Environmental, Missoula, MT

This study explores the use of elemental composition data to assess acid mine drainage (AMD) potential. In the proposed method, elemental composition is used to categorize samples into rock-type units (RTUs) using molar element ratio analysis (ioGas™). Regression equations are derived by comparing sulfur and calcium concentrations with Acid Base Accounting (ABA) results for each RTU. Subsequently, calcium and sulfur measurements are combined with regression equations to estimate the AMD potential of mine materials. Results from three separate mines sites demonstrate promising correlations between elemental composition and conventional laboratory ABA results suggesting that elemental composition can serve as a reliable proxy for AMD potential. Elemental composition can be measured using laboratory assay or portable X-ray fluorescence (pXRF). The ability to rapidly classify materials as potentially acid generating (PAG) or non-PAG in the field using pXRF measurements offers significant advantages for materials management and cost-savings.

3:05 pm

Automating Geochemical Sampling with Machine Learning: A Smarter Path to Representativity

G. Lehn, S. Wright, D. Warren and T. Meuzelaar; Life Cycle Geo, LLC, Denver, CO

Representative sampling for geochemical characterization is foundational to mine planning, resource estimation, and developing geometallurgical and environmental conceptual models, yet traditional sample selection methods are often manual and inefficient. Here we introduce an automated sampling workflow that integrates spatial, geological, and multi-element assay data. Assays are first transformed with the isometric log ratio (ILR); since an ILR basis is redefined for any element subset of interest, the workflow can target operationally significant geochemical signatures while adhering to best practices for compositional data analysis. A two phase coreset algorithm, mini batch k means followed by greedy k center, captures both modal compositions and outliers, ensuring comprehensive geochemical and spatial coverage. Validation confirms spatial, lithological, and chemical representativeness. This approach delivers reproduceable, high-quality datasets and cuts time developing a sampling analysis plan by an order of magnitude, offering a scalable solution for a range of geoscientific applications.

3:25 pm

Design Considerations for Semi-passive Treatment of Iron and Aluminum Rich Acid mine Drainage: Integrating Alkalinity Generation Beds, Lime Titration, and Sulfate-reduction Bioreactors

E. Wologo, R. Williamson, R. Spietz and L. Kirk; RESPEC, Bozeman, MT

High concentrations of iron, aluminum, and sulfate in acid mine drainage (AMD) can make implementation of a fully passive treatment system difficult due to fouling of treatment beds and high sludge loads. AMD sites may benefit from a semi-passive treatment strategy that would combine multiple treatment modules in series to overcome these challenges. Various configurations of steel-slag and limestone were evaluated for initial pH adjustment and compared to direct lime slurry titrations. Subsequently, various types of bioreactor media were evaluated for sulfate removal and alkalinity generation potential. Testing showed that mixed steel-slag/limestone beds can produce strong alkalinity but require careful management of iron armoring, aluminum precipitation, and gypsum formation. Direct lime slurry titration provides reliable pH control but requires more active management than a fully passive system. These results inform design considerations for developing a semi-passive treatment approach to achieve long-term AMD treatment success.

3:45 pm

Experiments in Geochemistry: Lessons Learned During Ramp Up of a Research and Development Laboratory

R. Adams[1], P. Moran[2] and J. Gillow[1]; [1]Arcadis, Denver, CO and [2]Rio Tinto, Salt Lake City, UT

Non-traditional laboratory tests offer valuable insights for mines with unique geochemistry, environmental conditions, and site-specific operational or closure needs. However, custom external testing is often costly and logistically challenging. This study shares lessons learned from establishing a small, hands-on R&D lab, including building a DIY kinetic testing system, conducting ion exchange water treatment columns, and performing tailings attenuation studies. We highlight successes, setbacks, and practical takeaways. This approach demonstrates how in-house testing can reduce costs, improve responsiveness, and support innovation in mine site characterization and treatment strategies.

4:05 pm

Honing In On Model Adsorption Parameters for Transport Modeling

B. Kimball and W. Linderfelt; INTERA Incorporated, Albuquerque, NM

In this case study, several different approaches were utilized to develop attenuation parameters for groundwater constituents of concern in a flow and transport model (FTM). Uncertainty in estimation of adsorption parameters was evaluated using four different methods: (1) using sequential extraction data for solid chemistry and groundwater data; (2) using a modified synthetic precipitation leach procedure for solid chemistry and groundwater data; (3) a surface complexation model (SCM) in PHREEQC using site-specific estimates for ferrihydrite concentrations; and (4) a method where adsorption parameters were fit to a calibrated FTM to obtain the best match to historical groundwater concentrations. The best estimates of adsorption parameters were those with overlapping values among the various approaches. Estimated parameters were applied to the FTM and adjusted where necessary. The current FTM forms the basis for ongoing modeling scenarios aimed to identify the best remediation strategies for the most mobile groundwater constituents of concern.

Monday, February 23
Afternoon

ENVIRONMENTAL: CLIMATE CHANGE, ENVIRONMENTAL CHALLENGES ON MINING

255D

Chairs: ***H. Kim****, AtkinsRealis, Highlands Ranch, CO*
L. Watson*, Watson Environmental, Tucson, AZ*

2:00 pm

Introductions

2:05 pm

Balancing Climate Change Parameters to Improve Facility Resiliency

B. Symons and V. Tandon; Foth Infrastructure & Environment, LLC, West Columbia, SC

Balancing potential climate change scenarios, resilience and, sustainability goals is crucial and site-specific. Three case studies from manufacturing, mining, and marine industries and different geographies were assesed for climate change effects on water modeling parameters to improve resiliency. For each case, available meteorological data and climate change modeling projections for the facility and region were developed. Various development scenarios were assessed using site-specific climate models and customized for each facility's available data, facility resiliency objectives, and critical site-specific climate effects. Results varied depending on the facility objectives, uncertainty of climate projections, and overall economic, social, and environmental complexity. Facility resiliency was evaluated for viability using climate change effects analysis and resiliency metrics. Right sizing climate modeling tools to the facility objectives, land area, and complexity created cost efficiencies and synchronized the level of effort to the project schedules. Lessons learned, including innovative approaches and areas for improvement, will be discussed.

2:25 pm

Emerging Decarbonization Technologies in the Mining Sector

M. McCulloch; Norda Stelo, Quebec City, QC, Canada

While the climate policy environment continues to shift, the decarbonization of mines continues to be a priority regardless of the stage of a mine's life. Initial levers of energy efficiency, renewable energy, and electric haul trucks are relatively well advanced and known, yet each mine has a different context that may limit its options or demand further reduction opportunities; particularly if they can be deployed sooner. This presentation will explore the most promising emerging decarbonization technologies in the mine space that are being piloted, or even commercialized, and showing promising results to help enable access to future markets. Topics to be covered include low carbon fuel alternatives, alternative heating technologies (including underground mine applications), CO2 mineralization pathways and value-add uses, vehicle-to-grid applications for revenue generation, next generation comminution, and next generation CO2 capture. Case studies will highlight which technologies best suit different mine contexts.

2:45 pm

26-052

Reducing Emissions at ArcelorMittal

R. Vivas; Hexagon Mining, Tucson, AZ

This presentation shows how ArcelorMittal has been able to significantly reduce emissions at their Peña Colorada Mine over the past 10 years. The results are compelling: based on the Life of Mine (LoM) plans from 2012 and 2016, annual emissions reductions of 14,000 tCO2e and 9,200 tCO2e were achieved respectively. These reductions correspond to a 26% decrease in waste mined compared to the 2012 plan and a 19% decrease compared to the 2016 plan. To put this into perspective, 14,000 tCO2e is equivalent to the annual carbon footprint of over 3,700 Mexican residents. Over the past decade, ArcelorMittal has invested significant resources in technological innovations to improve its business practices. These efforts have resulted in substantial reduction of waste mined and associated emissions while also lowering the operational and capital costs. This presentation highlights the decade-long progress in emissions reduction and explores how technology can continue to drive environmental performance in mining.

3:05 pm

26-058

Strengthening Urban Water Management Amidst Climate Change and Socio-Environmental Conflict: Integrating Environmental Campaigns and Mining-Funded Water Infrastructure Solutions in Cajamarca, Peru

M. Mendoza Tirado, R. Arévalo Saavedra and N. Portal Ravichaua; SME UNC, Cajamarca, Cajamarca, Peru

This study analyzes the implementation of an integrated strategy for environmental education and community awareness in Cajamarca, Peru—an Andean region affected by climate variability and the public perception of mining-related water shortages. In collaboration with the Interactive Water and Earth Museum and the Newmont ALAC Foundation, three-month campaigns were conducted in schools and local communities. Key topics included the water cycle, climate change, and water availability, linked to urban infrastructure projects that improved flow rates through strategically located tubular wells tapping underground aquifers. The initiative addressed the challenge of communication in a context where mining is often blamed for scarcity, fostering scientific understanding of contributing factors. The study highlights how science-based outreach and institutional collaboration can strengthen resilience and promote sustainable water stewardship in mining-influenced regions.

3:25 pm

Beyond Bugs and Bunnies – Integration of Environmental Design in Early Mine Planning

K. Wherry; Hatch, Mississauga, ON, Canada

The mining industry has for decades acknowledged the need to conduct environmental baseline studies and identify permitting requirements early in the project exploration and conceptual study phases. Often overlooked in the early mine planning phases is the need to identify the environmental regulations and industry standards for incorporation into the overall engineering design to avoid potential increased project costs or schedule changes resulting from design rework/changes due to late consideration in the project planning lifcycle (feasibility/detailed design). This paper identifies an integrated and holistic approach to integrating environmental design into engineering design throughout all project planning phases, starting at conceptual design, to drive responsible business investment and social performance by ensuring environmental and social needs are considered.

3:45 pm

Testing A Participatory Mapping Methodology for Integrating Community Knowledge and Methane Risk Assessment in Legacy Coal Mining Regions in Colombia

S. Escudero[2], K. Smits[2], J. Zarazaga[2] and O. Restrepo Baena[1]; [1]Universidad Nacional de Colombia Sede Medellin, Medellin, Colombia and [2]Southern Methodist University, Dallas, TX

This methodology integrates participatory mapping and GIS, ethnographic research, mining knowledge to explore, document and assess methane risks and ventilation challenges in legacy coal mining communities. More Familiar in environmental and urban research, participatory mapping strategies are adapted to the specialized community and knowledge of the mining sector in an integrated methodology. Built around a series of collaborative workshops with academics, local miners, and regional experts in Amaga Colombia, the process combines local knowledge with spatial analysis to identify critical zones of mining impact and community vulnerability. This approach fosters stakeholder engagement, improves environmental and safety assessments, and supports data-driven decisions for sustainable mine development, be it management or closure supporting mining- community resilience. Tested with a small coal mining community in Colombia, the methodology is Adaptable to diverse regions, particularly those with limited records, this methodology offers a practical, inclusive model for integrating social and technical data in mine transition planning and mining sustainability programs worldwide.

4:05 pm

Assessing Land use Impact of Critical Mineral Mining Production: A Case Study of the DRC Copper-Cobalt Belt

D. Otarod[1] and K. Awuah-Offei[2]; [1]Student, Springfield, VA and [2]Professor, Rolla, MO

As the global demand for critical minerals continues to grow, understanding the environmental consequences of their extraction becomes increasingly vital. In addition, global climate mitigation strategies increasingly rely on the extraction of energy-critical minerals, making it essential to deepen our understanding of their land use impacts. This study focuses on estimating the land use intensity as a key metric for evaluating the environmental footprint of mining operations. We present a comprehensive analysis in the DRC by examining mining footprints, production volumes, waste dumps, tailings, and geographic variability. We used satellite images to accurately quantify land disturbance. The evaluation of land use intensity was conducted across 20 mining sites over a period of 23 years. Our analysis indicates substantial land cover changes surrounding the mines, closely linked to production volumes. Higher production levels correspond with increased land transformation, particularly in areas designated for mining. These shifts have significantly impacted the region's vegetation and biodiversity.

Monday, February 23
Afternoon

HEALTH & SAFETY: RETHINKING SAFETY SYSTEMS: WHAT'S WORKING, WHAT'S NOT, AND WHAT'S NEXT

Sponsored by RioTinto

250A

Chairs: ***E. Haas****, National Institute for Occupational Safety and Health, Pittsburgh, PA*

T. Hethmon*, Sandy, UT*

2:00 pm

Introductions

2:05 pm

Whole Systems Safety: A New Framework for Management System Optimization

T. Hethmon; Hethmon Associates LLC, South Jordan, UT

Risk-centered safety and health management systems (SHMS) are the most common management tool used in the mining industry to minimize morbidity and mortality and are regulatory requirements in the majority of mining countries. Despite decades of use, there is no consensus regarding the optimal SHMS design. What is agreed is the extensive number of variables involved in effective mine safety and health management and the need for SHMSs to reflect this scope. However, this is seldom accomplished. Whole System Safety is a new design framework to optimize the structure, implementation, integration and assurance of SHMSs. It incorporates systems thinking, sustainable change and complexity reduction principles. While applied to safety in this context, it is relevant to any management system application, e.g., operations. This presentation will summarize the Whole Systems Safety rationale, principles, practices and highlight related case studies.

2:25 pm

A Whole Systems Appraoch to Analyzing, Operational, Maintenance and Safety Error Data: Investigating Leading Indicators for Safety Performance

P. Guild and P. Rogers; University of Utah, Magna, UT

Modern mining operations function as complex socio-technical systems, where technological optimization often outpaces reactive safety initiatives. Overreliance on lagging indicators and reductionist problem-solving yields short-term fixes but limits long-term resilience. This research applies multivariate time series analysis and pattern discovery to error data across key operational domains—including safety events, downtime, unplanned maintenance, production variance and missing critical controls. Findings reveal interdependent patterns linked to system stability and safety outcomes. The study proposes a holistic framework for predictive safety analysis, offering data-driven insights to support proactive interventions and adaptive risk management in high-hazard industrial environments.

2:45 pm

Safety Risks Associated with Data Management at an Operating Mine Site

J. Gillon[1] and Z. Mcleay[2]; [1]Deswik USA Ltd, Lakewood, CO and [2]Pogo Mine, Delta Junction, AK

As mining turns to technology searching for improvements in productivity and efficiency, managing the data generated by these systems introduces an often overlooked set of safety and commercial risks. Referencing multiple real-world incidents, we will discuss the risks associated with data governance, deficiencies in the current approach, and the nature of these risks. In this paper we argue that a comprehensive approach to data governance is critical to any future safety plan and that a sense of urgency is warranted as both the risks and costs to address the problem will increase as more data is generated. We will follow up with a case study from Pogo Mine, a large-scale underground mining operation that recognized these risks and implemented a data management platform. We detail the motivation behind this decision, the evaluation criteria used to select the system, and the challenges encountered during implementation, concluding the presentation with a discussion on the current system and lessons learned during the experience.

3:05 pm

Performance Oriented, Human Centered, Operational OH&S Performance

E. Ramon Huergo; MD, Miami, FL

In the mining industry and others, success is often measured by misleading indicators, such as program implementation, certification, "zero accident" records, etc. These metrics, while popular, can distort organizational focus, drive counterproductive behaviors, and encourage unsafe decision-making, especially among leaders with the authority to influence priorities and allocate resources. This presentation challenges conventional notions of performance and success. It proposes a practical, human-centered approach to Occupational Health and Safety (OH&S) operational excellence. Simplifying complexity, fostering aligned understanding of performance across all levels ("Just cause"), focusing on consistent, highly effective communications, techniques, organizations can unlock, self-sustaining performance, avoiding "cognitive conflict" at operational levels and delivering risk reduction, in high turnover operational environments. Using real-world insights and tools, this approach offers a replicable path toward OH&S operational excellence that not only improves safety outcomes but also enhances the overall effectiveness of the organization, regardless of the metrics being pursued.

3:25 pm

26-056

Scalable Framework for Worker Safety Assessments Inspired by Navajo Nation Mine Reclamation

A. Woodward[1], M. Gillian[2] and S. Hammond[2]; [1]UC Berkeley, Oakland, CA and [2]UC Berkeley, Berkeley, CA

This paper presents a scalable framework for worker safety assessments. The case study site location focuses on uranium mine reclamation in underserved communities, specifically Cove Chapter of the Navajo Nation. The proposed framework integrates field observations, OSHA data analysis, systems mapping, and a hierarchical occupational health pyramid, to identify site-specific hazards while addressing broader socio-cultural dynamics. The approach improves upon existing safety programs by suggesting actionable, locally sensitive solutions that prioritize higher-order controls such as hazard engineering interventions and administrative controls. This study contributes to enhanced worker safety, environmental restoration, and community engagement for marginalized regions with abandoned mine lands (AML). The scalability of this framework for safety analysis also has broader implications for AML projects across the United States and has the potential to be adapted for active mine sites by utilizing the Mine Safety and Health Administration (MSHA) database.

3:45 pm

Safety-Driven Production and Continuous Improvement

J. Savit; Hexagon Mining, Tucson, AZ

The trend towards automation and data exchange is well established in mining, but what lies beyond Industry 4.0? How can production demands be met without compromising safety? To create safety-driven production in open-pit and underground mines, a unified, accessible platform with layered systems for collision avoidance, operator alertness, personal protection, and vehicle intervention is important. Underground and surface mining have similar but distinct complexities. Over-reliance on technology to solve those complexities can increase associated risks. As mines dig deeper pits or push beneath the surface for deposits, the need for better communication and collaboration increases. Mining operations are a precisely coordinated performance; each piece of equipment operates in harmony under the guidance of its operator. Every movement must be deliberate and calculated. Recognizing this dynamic provides an opportunity to design safety systems that not only enhance protection but also serve as tools for optimizing production. This paper will explore the intersection of technology and trust as it relates to the management of change and the strengthening of safety culture.

4:05 pm

Rethinking SIF Prevention – Models, Mindsets, and Missed Opportunities

L. Guasta; Environmental Resources Management, Denver, CO

Over the past decade, numerous SIF prevention models have emerged from leading organizations. Most converge on familiar frameworks — PDCA cycles, high-energy source identification, and Human and Organizational Performance (HOP) principles. Yet despite good intentions and extensive research, SIF rates have plateaued even as total recordable injury rates continue to decline. This session explores a critical question: Are we complicating the path to SIF prevention by constantly reinventing it? As we chase the latest shiny object in the name of innovation, we may be losing sight of proven fundamentals. The presenters will challenge prevailing assumptions, examine the actual value of HOP in SIF modeling, and propose that a "back to basics" approach—focusing on risk amplification and psychological safety—may offer a more sustainable path forward. Key learning outlcomes include: Better understanding of the broader SIF landscape and why workplace-only strategies fall short; exploring the role (and possible overuse) of HOP in current SIF frameworks, and learning how smaller organizations can lead SIF prevention by focusing on psychological safety and risk mitigation.

Monday, February 23 Afternoon

HISTORY OF MINING I

155D

Chairs: ***G. Luxbacher****, MELM Consulting, Dawsonville, GA*
S. Shoemaker*, John T Boyd Company, Tooele, UT*

2:00 pm

Introductions

2:05 pm

J. R. DeLamar - The Greatest Miner You Never Heard of

T. Arnold; retired, Sparks, NV

Joseph Raphael De Lamar (September 2, 1843 – December 1, 1918) was an American politician and businessman who owned and operated mines in the western United States and Canada. After working as a ship's captain, a contractor and a trader in the maritime industry, he entered the mining business in the late 1870s. His impact on mining was enormous, and this presentation will explain his mining and personal journey.

2:25 pm

Meeting in the Bowl of Gold - A Family's Journey with Famous Places and People in the Mining West

S. James; ZincMet Consulting, Clarksville, TN

My decision to pursue a career in mining and metallurgical processing has its roots in the journeys of my ancestors across the Mountain West region of the United States. A man and a woman from very different backgrounds met in Cripple Creek, Colorado, known as the "Money Mountain." During their time there and in other mining camps and towns, they rubbed shoulders with famous and infamous characters. Stories told to me by my grandmother of her time as a young girl and woman in Colorado mining camps began my lifelong passion for mining history. This personal story follows members of my family as they lived in these camps during the period of westward expansion and encountered notable figures such as Winfield Stratton, Spencer Penrose, William Palmer, Jimmy Doyle, Alberrt Carlton, and Harry Orchard. They lived through the Silver Crash of 1893, labor upheavals of the mid-1890s, the boom period of the Greatest Gold Camp on Earth, before settling back to life on a farm - with detours into bootlegging and an oil well.

2:45 pm

Goodbye, Farewell, and Amen!

D. Kanagy; SME, Englewood, CO

SME's legacy dates from the founding of AIME in 1871 – change has been the constant theme over the intervening 155 years. Borrowing the title from the last episode of the long-running TV show, M*A*S*H, this presentation by the outgoing SME Executive Director offers reflections on more than two decades of experience in the mining industry, highlighting key changes (commodity prices, automation, public interest), challenges, and achievements. It explores the evolution of safety programs, environmental responsibility, community outreach, technological advancements, and regulatory expectations. Drawing on personal insights and industry trends, this presentation will provide some retrospective look at the lessons learned at several key moments. Several important mining traits will be explored with a focus on leadership and the enduring importance of responsible resource development. The presentation concludes by considering the future of the SME and role it can and will play in advancing the industry, continuing the key role the AIME founders envisioned in 1871.

3:05 pm

The History of Gold Mining in Harrison Gulch, Shasta County California

S. Shoemaker; John T Boyd Company, Tooele, UT

In the early 1890s, a group of prospectors discovered gold in the far southwestern corner of Shasta County California. This discovery would come to be known as the Midas Mine and the town of Harrison Gulch formed near the discovery. Serval significant gold mines were discovered adjoining the Midas Mine and the area entered a sustained period of extensive mining that lasted the next 20 years. During this period, the mines in Harrison Gulch were the largest gold producers in Shasta County. In 1914, a fire in the Midas Mine closed the operation. Mining continued in the area into the 1920s with the last mining in the late 1930s. Today, nothing remains of the townsite and mines. This paper will describe the history of the gold mining operations in Harrison Gulch including their discovery, operation, and final closure.

3:25 pm

French Creek Mines, Chester County, PA - Some History and Current Findings

A. Sheckler, M. Feineman and B. Arnold; The Pennsylvania State University, University Park, PA

The French Creek Mines in Chester County, PA, were first worked in 1717 and eventually closed in 1928, after producing iron ore (magnetite) and, secondarily, copper. With increased interest in prior mine and processing plant locations related to critical minerals, Penn State researchers have been "digging" into old samples and have uncovered a potential source of rare earth elements in the mine tailings. This presentation will review the history of the French Creek Mines, what sets them apart from other iron mines in the area, and the potential for recovery of rare earth elements from these old workings.

3:45 pm

Factors Influencing Bituminous Coal Production in Western Pennsylvania

G. Iannacchione[1] and A. Iannacchione[2]; [1]Iron Senergy, Waynesburg, PA and [2]Univ. of Pittsburgh, Pittsburgh, PA

Coal has been extracted in western Pennsylvania for over 250 years. For example, mine adits along the slopes of Mount Washington and across from Pittsburgh's golden triangle produced coal used at Fort Pitt during the French and Indian War (PA DEP website). Pennsylvania coal production steadily increased until reaching a maximum prior to World War I (Figure 1). Initially, Anthracite coal from eastern Pennsylvania dominated. Today, bituminous coal dominates. By 1983, Pennsylvania bituminous coal production increased to over 65 million short tons while anthracite coal totaled less than 4 million short tons. In 2023 surface mining accounted for only 2.4 million tons while underground mining achieved 37.4 million tons. Underlying factors include the adoption of longwall mining systems, the disappearance of pillar recovery operations, and the adoption of continuous mining systems for room-and-pillar operations. However, since 1998, Pennsylvania underground mining production has declined at a steady rate.

Monday, February 23 Afternoon

INCLUSION & DIVERSITY: INCLUSION & DIVERSITY IN MINING - CHALLENGES AND OPPORTUNITIES

250B

Chairs: ***V. Gosteva****, ES Consulting, Denver, CO*
M. Parker*, Piedmont Lithium, Charlotte, NC*
S. Debur Nagarajan*, Geocomp, New York, NY*

2:00 pm

Introductions

2:00 pm

Get Excited to Work in Mining! A Comprehensive Approach to Attracting and Retaining Talent in the Mining Industry

S. Saffold-Harris[1], A. Anani[1], J. Potter[1], K. Luxbacher[1] and C. Abramson[2]; [1]University of Arizona, Tucson, AZ and [2]Rice University, Houston, TX

In the United States, gender composition is pivotal in employee retention and talent acquisition within the mining industry. Women constitute approximately 17 percent of the global mining workforce. However, in the US context, there is a notable trend of women exiting the mining sector, coupled with a tendency for current employees to refrain from referring women to available job opportunities. The research examines how women working in mining can impact the workforce in talent retention, marketing, and mentoring future miners. Using qualitative and quantitative data collected between 2023 and 2025 from women working in mining within the United States, this project examines where intervention is required for mining to achieve the desired increase in workforce, decrease talent attrition, and increase talent attraction.

2:20 pm

Mining and Community Resilience: A Cross-Continental Analysis of Impacts and Responses

F. Gil; WSP, St. Louis, MO

The expansion of mining in resource-rich regions offers substantial economic potential but also introduces complex social challenges for surrounding communities. This paper examines the social impacts of mining on populations residing near extraction sites in countries with longstanding mining traditions, including Peru, South Africa, and the United States. It addresses recurring concerns such as displacement and economic disruption, as well as varied community responses including activism, negotiation, and adaptive resilience. Through a comparative analysis of governance frameworks and local reactions, the study identifies key drivers of social conflict and presents recommendations based on case studies where mutually beneficial agreements were successfully achieved.

2:40 pm

Maximizing Human Potential: Insights from the Field

S. Briscoe; The Discovery Files Podcast, Nixa, MO

Based on first-hand experience and interviews with high-performing individuals across technical teams, this talk explores how leaders can unlock untapped potential by recognizing and aligning individual strengths with team objectives. We examine common patterns in environments where people thrive—highlighting the role of intentional listening, psychological safety, and strategic role alignment. Rather than relying on theory alone, this session presents real stories and practical frameworks for optimizing team performance through better human understanding. Attendees will leave with actionable tools to enhance collaboration, elevate overlooked contributors, and create conditions where people are empowered to succeed.

3:00 pm

DEI Starts with "I": Embracing the Individual to Build True Inclusion

H. Thomas; Geovert, Commerce City, CO

Too often, DEI efforts rely on broad categories like culture, gender, or background without fully considering the individuals within them. But people are not checkboxes. Real inclusion begins by understanding and working with people as they are, not just who we assume them to be. This presentation explores how centering individuality can create more authentic and lasting DEI outcomes. We will look at how to engage with different cultures and genders through a lens of curiosity rather than assumption, and why forcing change is less effective than shifting perspective. Teaching individuals how to work with other individuals is where real progress begins - and that everyone deserves to have a seat at the table. DEI is not static. It evolves, just like people do. This session will offer grounded and practical tools for meeting others with openness, adjusting our own lens, and making room for new ways of thinking and connecting. Because change does not start with policy. It starts with understanding people.

3:20 pm

Insights Across Borders: Reflections on Mining Practice and Education in Zimbabwe and the U.S.

C. Chinyadza and N. Risso; University of Arizona, Tucson, AZ

Mining in Zimbabwe is characterized by a dual structure of artisanal and small-scale mining (ASM) alongside large-scale mechanized operations. As demand for mineral resources continues to grow, these sectors remain pivotal to the nation's economy despite facing significant challenges related to safety, environmental management, and technological advancement. Women in Zimbabwean mining encounter additional barriers, including gender-based discrimination and limited access to technical roles. This presentation shares my journey as a woman in Zimbabwean's mining industry, drawing from experiences in ASM and large-scale mining. It examines cultural and structural challenges shaping women's participation, ASM safety realities, and operational dynamics of large-scale mines. It also reflects on my transition to graduate studies in mining engineering in the U.S., highlighting academic, cultural, and professional shifts. This talk discusses knowledge gaps I wish had been addressed before entering Zimbabwe's mining sector and studying abroad. It offers lessons on academic readiness, industry expectations, cultural adaptation, and gender dynamics to inspire young leaders to be resilient.

3:40 pm

The Importance of Integrating Indigenous Knowledge into Engineering for Mining

C. Burdon; Elevate Engineering, Calgary, AB, Canada

As mining operations increasingly intersect with Indigenous lands, integrating Indigenous knowledge into engineering emerges not only as an ethical imperative but also as a practical necessity. This paper explores the profound value of Indigenous knowledge systems in informing geotechnical practices, improving environmental stewardship, enhancing risk management, and fostering respectful partnerships between mining companies and Indigenous communities. By recognizing the depth and relevance of Indigenous ecological, geological, and cultural insights, earth science engineers can develop more sustainable, site-specific, and socially responsible mining projects. Central to this integration is the Two-Eyed Seeing framework, which emphasizes the importance of viewing the world through both Indigenous and mainstream or conventional scientific lenses.

4:00 pm

Breaking New Ground: Creating Space for Every Voice

M. Dang; Invited Moderator, Bellevue, WA

The mining industry continues to push the boundaries of innovation, safety, and sustainability, but the next frontier lies in how we build and lead diverse, inclusive teams that reflect the global communities we serve and retain key personnel. Breaking New Ground: Creating Space for Every Voice is a session tailored for engineers in mining, highlighting real-world stories and strategies that drive belonging, collaboration, and improved performance in technical and operational settings. This session will feature perspectives from four professionals who bring decades of engineering and field experience. Engineers attending this session will gain actionable strategies to improve team cohesion, safety, and retention, while hearing authentic experiences that challenge traditional norms and showcase how diverse voices strengthen engineering excellence.

Monday, February 23
Afternoon

INDUSTRIAL MINERALS & AGGREGATES: CRITICAL AND BATTERY MINERALS I

250D

Chairs: ***T. Gupta****, MP Materials, Mountain Pass, CA*
R. Dube*, Metso USA, Centennial, CO*

2:00 pm

Introductions

2:05 pm

Geochemical Reconnaissance of Alunite: An Unconventional Resource of Aluminum and Potash, Beaver and Iron Counties, Utah

A. Rupke and T. Boden; Utah Geological Survey, Salt Lake City, UT

Alunite, a hydroxylated sulfate mineral, is a potential resource of both aluminum and potash (as potassium sulfate) in Utah. Globally, alunite deposits have intermittently been mined to produce both commodities. Historically, U.S. production of alunite is limited, but a large, well-defined, and unexploited alunite deposit is present in southwest Utah—the Blawn Mountain deposit. Additional alunite deposits are present near this known resource that could be a valuable supplement to that deposit, and mapping and sampling are currently underway to investigate the grade and extent of those less-known deposits. Unconventional alunite deposits could represent an important domestic source of aluminum and potash in the future.

2:25 pm

Valuable Mineral Recovery and Alternative Utilization of Produced Water through a Novel Process

W. Zhang[1], Y. Pan[1], P. Liu[1], A. Haynes[2], C. Doherty[2] and K. Obuli[3]; [1]Virginia Tech, Blacksburg, KY; [2]North Carolina State University, Raleigh, NC and [3]Austin Elements Inc., Houston, TX

Produced water is characterized by high salinity (primarily from Na and K) and hardness (Ca, Mg, and Ba), which limits its usability beyond oil and gas operations. However, it also contains appreciable concentrations of lithium, along with trace amounts of rare earth elements (REEs) and other critical metals (CMs), offering both opportunities and challenges for resource recovery. An interdisciplinary team from Virginia Tech, North Carolina State University, and Austin Elements Inc. is conducting a project to develop an integrated process that combines REE recovery, direct lithium extraction, carbon mineralization, and phyto-microbial treatment for the comprehensive utilization of produced water. After more than a year of research and development, the technical feasibility of key process components has been demonstrated, resulting in several important findings. This presentation will offer a high-level overview of the project and highlight major advancements and discoveries.

2:45 pm

Process Flowsheet Development for Niobium and Rare Earth Production from the Regoliths Associated with the Hicks Dome Deposit

K. Sierra, B. Ji, S. Hanson and R. Honaker; University of Kentucky, Lexington, KY

The rising demand for rare earth elements (REEs) and niobium (Nb) coupled with supply chain uncertainties emphasizes the importance of stable domestic sources. The Hicks Dome deposit located near Rosiclare, Illinois represents a potential resource that occurs in surface accessible regolith materials and breccia rock located 1500 feet below surface. In this study, drill core samples from the regolith materials were characterized using mineral liberation analysis, X-ray diffraction, inductively coupled plasma, and scanning electron microscopy with energy dispersive spectroscopy. Samples were found to contain 2.66% REEs associated with monazite, xenotime and florencite and 0.50% Nb in the mineral pyrochlore. Core samples varied in grade with lower grade materials associated with finely liberated REE minerals. Initial process flowsheet development focused on physical concentration methods to upgrade the valuable minerals and maximize the rejection of problematic minerals prior to the subsequent hydrometallurgical processes.

3:05 pm

Re-Evaluating Historic Graphite Resources in the Central Texas Graphite District

S. Short, B. Elliott and J. Kyle; The Bureau of Economic Geology, Austin, TX

The Central Texas Graphite District, within the Precambrian Llano Uplift, hosts graphite mineralization in the Packsaddle Schist which was historically exploited at the Southwestern Graphite Mine. Production occurred intermittently in the early 20th century with estimated production of 75,000 metric tons. Mineralization follows a NE-SW trend and dips approximately 80°, forming tabular ore zones up to 1,400 ft in length and 150 ft in width, locally intruded by granitic dikes. Digitization of a 1920s–1930s driller's logbook shows assay data from 70 core holes sampled at 5-foot intervals. These data form the basis for 3D geological modeling and geostatistical resource estimation using open-source Python tools. Structural controls and spatial anisotropy are integrated into the model to refine estimates of grade distribution, tonnage, and uncertainty, to evaluate remaining graphite resources under current market conditions.

3:25 pm

Investigation of Binder Liberation from Grey Mass Using an Ultrasonication Sequenced with Centrifugation

U. Kar[1], C. Locke[2] and P. Chu[1]; [1]University of Nevada, Reno, Reno, NV and [2]Chemistry Department, University of Nevada, Reno, Reno, NV

The primary objective of this study is to develop an effective and eco-friendly binder liberation process for lithium-titanate oxide (LTO) grey mass recovered from spent lithium-ion batteries (S-LIBs). The proposed process employs ultrasonication to facilitate the liberation of polyvinylidene fluoride (PVDF) binder from active materials. Sodium dodecyl sulfate (SDS) is introduced as a frother to enhance the stability of the froth generated by cavitation bubbles. This increases the liberation efficiency via initial separation based on hydrophobicity. Subsequently, centrifugation is used to separate the liberated particles based on their density differences. To evaluate the environmental impact of the process, a life cycle assessment (LCA) was conducted and compared against conventional binder removal techniques, including pyrometallurgy, solvent treatment, and cryogenic grinding. The findings demonstrate the potential of this approach as an alternative pretreatment step.

Monday, February 23 Afternoon

INDUSTRIAL MINERALS & AGGREGATES: INNOVATIONS IN INDUSTRIAL MINERALS AND AGGREGATES

250C

Chairs: ***G. Tomaino****, Minerals Technologies Inc, Easton, PA*
B. Li*, Michigan Technological University, Houghton, MI*

2:00 pm

Introductions

2:05 pm

Digital Prospecting for Decarbonization: How AI and GIS Are Powering Pozzolan Discovery

S. Burgess; SME, Midvale, UT

As global cement producers race to decarbonize, natural pozzolans offer a transformative opportunity for mining to lead the charge. By leveraging AI and GIS technologies, we've developed a system to identify and prospect viable natural pozzolan sources in the Western U.S., strategically pairing them with nearby cement plants to reduce transportation emissions and replace high-carbon SCMs like fly ash. This session explores how digital tools are redefining resource targeting and enabling mining to meet ESG demands while supporting sustainable infrastructure. At the crossroads of innovation and necessity, mining may just be the unexpected hero in cement's low-carbon future.

2:25 pm

Technological Evolution in Italy's Dimension Stone Industry: Advances in Extraction, Processing, and Sustainability

M. Cardu; POLITECNICO DI TORINO, Torino, TO, Italy

Italy has played a key role in the global dimension stone sector, which is supported by high-quality resources and a strong industrial base. This paper outlines the technological evolution of the Italian industry from the late 20th century to today, focusing on advances in extraction and processing. A shift from conventional methods to high-efficiency technologies, such as diamond wire cutting, precision drilling, and Computer Numerical Control (CNC) machinery, has significantly improved productivity and safety. Integrating digital modeling, automation, and process monitoring has modernized workflows. Meanwhile, environmental pressures have driven the adoption of cleaner solutions, including closed-loop water systems and energy-efficient equipment. Italian manufacturers and quarry operators have often led these changes, setting global benchmarks. This analysis highlights how innovation has reinforced Italy's competitiveness in a globalized mining economy, while aligning with rising standards of sustainability and precision.

2:45 pm

Predicting Market Capture for Prospective Quarries: Integrating Consumption Distribution, Transportation Networks, and Economic Competitiveness

A. Valian and B. Groff; Groff Engineering, Lexington, KY

This study presents a GIS framework for predicting the market capture of potential quarry sites and visualizing them as intensity maps. It accomplishes this by integrating three critical domains: consumption distribution, network-based haulage, and economic competitiveness. Market share is estimated by combining these datasets through an economic decay kernel, where attractiveness is defined as the inverse of delivered cost raised to a tunable exponent. The resulting intensity maps reveal strong and weak market penetration zones for the prospective quarry. The modular structure of this method lays the groundwork for incorporating additional technical and socioeconomic inputs for further enhancements. This approach introduces transparent, rule-driven analyses into a field traditionally dominated by subjective or simplistic methodologies, enhancing the reliability of aggregate market studies.

3:05 pm

An Alternative to Dredging: Mobile Mining Solutions for Challenging Deposits

D. Pepper and A. Kuhn; AusIMM, Carrara, QLD, Australia

Dredge mining is often preferred for high-tonnage mineral sands deposits, but environmental or hydrologic constraints can make it unviable. A mobile mining unit (MMU) provides a practical alternative for such conditions—particularly where loose, friable sands make conventional truck-and-shovel mining inefficient. The track-mounted MMU operates in-pit with single-operator control, delivering 600–750 TPH while eliminating the need for articulated truck fleets. Electrically powered and easily maneuverable, the MMU minimizes disturbance, improves safety, and maintains consistent feed rates in deposits that cannot be mined by dredge. This approach enables sustainable, high-efficiency mining in areas where traditional methods fall short.

3:25 pm

Applications of Bentonite for Solidification of Drifting Sands and Desert Controls – An Update

B. Li[1], X. Xu[2], W. Zhang[2], F. Li[3] and G. Fu[2]; [1]Michigan Technological University, Houghton, MI; [2]Gansu Institute for Desert Countrol, Lanzhou, Gansu, China and [3]Jianping Qingjian Mining Co, Chaoyang, Liaoning, China

Bentonite clay has unique and excellent properties such as hydrophilicity, swelling, lamination, small grain size, and easy processing, as well as broad distribution as a mineral resource. These properties have been already developed for applications, but many potential utilizations still remained to be exposed. We used bentonite and solid wastes from mineral processing to solidify the surfaces of drifting sands and dunes. This paper is an update to our continued field experiment after scale-up.

3:45 pm

Sustainable Fuel Switching in Cement Production: A Cost-Benefit and Sustainability Analysis

P. Duah and K. Awuah-Offei; Missouri University of Science and Technology, Rolla, MO

Coal combustion in cement kilns is a major source of greenhouse gas emissions. This study evaluates the environmental and economic impacts of substituting coal with tire-derived fuel (TDF), biomethane, and natural gas in clinker production across various kiln technologies. TDF was selected for its high heat content, combustion efficiency, and lower emissions per million Btu. Various fuel substitution levels were explored relative to baseline coal usage. Results show that these alternatives offer measurable emissions reductions and cost benefits. The findings suggest that policy support should promote the adoption of sustainable fuels to enhance environmental performance and economic viability in cement manufacturing.

4:05 pm

Precision Pond Mapping: Drone Based, Dual Frequency Bathymetry Survey Results at a Texas Limestone Quarry

M. Lee; Westward, Boerne, TX

In May 2025, Westward's Geology Group conducted a successful drone-based, dual frequency bathymetry survey at Knife River's active limestone quarry in Texas. Knife River required accurate data on the capacity of ponds near the plant. Westward utilized a drone equipped with a dual-frequency echo sounder to map the top of sediment and the underlying consolidated sediment in the ponds. A LIDAR survey was also flown to estimate the amount of freeboard available in the pond and get updated elevation data of the ponds.

Monday, February 23
Afternoon

MINING & EXPLORATION: GEOSCIENCE: ADVANCING RESOURCE ESTIMATION AND OREBODY PRECISION

250F

Chairs: ***M. Locmelis****, The University of Texas at Austin, Rolla, MO*
D. Reid*, SRK Engineering*

2:00 pm

Introductions

2:05 pm

Challenges on Data Spacing for Resource Classification

R. Cooper and D. Silva; Newmont Mining, Parker, CO

With increasing economic regulation, mineral resource classification is a central industry consideration. It is an economic statement grounded in geology, resource estimation, and mine planning. A common classification approach uses drill data spacing to assess the probability of achieving defined economic targets. This requires geological and grades simulations, as well as mine plans with defined cutoffs, sequencing, and production rate scenarios. Historical analogs and past data spacing practices are inadequate for modern feasibility studies due to changes in methodology and analytical rigor. A transparent methodology that clearly addresses geological domaining, anisotropy, and spatial factors is essential for a legitimate and defensible resource statement.

2:25 pm

A Standardized Approach to Ore Reserve Risk Classification

J. CLARK; Nevada Gold Mines, Elko, NV

Geologic risk is inherent in all orebodies. While technical services aim to reduce variability, risk is rarely quantified meaningfully in short- to mid-term plans. Resource categorization reflects uncertainty at the deposit scale but is often misused as a proxy for local confidence. Standardized workflows may produce smoothed models that fail to reflect short-term variability—resulting in credibility loss and resequencing when stopes underperform. Qualitative risk matrices exist, but are subjective, inconsistently applied, and difficult to maintain. To address this, we introduce DrillCat: a standardized, auditable workflow using Deswik tools to quantify short- to mid-term orebody risk (1–5 YP) across three dimensions—data density and orientation, short-range grade variability, and known dilution risks. DrillCat assigns a quantitative rating to each mining entity, offering transparency and flexibility in scheduling. An example is presented from the Cortez District, Nevada.

2:45 pm

26-063

Uncertainty in Mineral Resources: Why It Should Be Part of a New Mining Ethos

M. Rossi; GeoSystems International, Inc, Boca Raton, FL

In mineral resources, geologic and mining data are acquired, processed, analysed, interpreted and modelled, eventually serving as basis to generate predictions and production plans. This is a complex process, and the resulting predictions are impacted by uncertainties related to the data itself and the processing methods and techniques used. They are also impacted by the subjective decisions made by the modeler(s) at each step of the way. Knowledge, biases, skills, and prior experience come into play in the long mineral resource evaluation development workflow. It is meaningless to discuss uncertainties without evaluating the associated risks that those uncertainties imply. It is important to quantify and assess uncertainty, and to evaluate and mitigate its consequences. This paper discusses (1) conceptual and practical sources of uncertainty; (2) the utopia of an "objective" uncertainty; and (3) the quantification and public reporting of uncertainty. The objective of this paper is to postulate that the industry is running out of reasons and excuses to ignore uncertainty and risk in project evaluation.

3:05 pm

Kriging Can't Save You from Your Spreadsheet Sins

C. Da Silva, K. Chislett and C. Wilson; Rio Tinto, Spring Creek, NV

Poor data quality introduces structural and statistical artifacts into ore body models, leading to flawed interpretations and suboptimal decisions. This presentation outlines how unclean geoscience data—ranging from misaligned lithological logs to inconsistent assay records—can propagate through estimation workflows, distorting grade continuity and resource classification. Case studies will demonstrate the operational consequences of these issues, including misinformed mine planning and reconciliation failures. By applying targeted data cleaning, validation and integration techniques, we show how to restore model integrity and reduce decision risk—because when garbage goes in, garbage comes out.

3:25 pm

Revisiting the Statistical Control Charts in the Assay Data QA/QC

A. Samal; GeoGlobal LLC, Riverton, UT

The Statistical control charts used in the presenting the QA/QC results of assay data in the mineral exploration and mining. A control chart has three horizontal lines derived from the (assumed) normal distribution with mean (μ) and standard deviation of σ of the CRMs (Certified Reference Material) or standards. The center horizontal line represents the mean (μ) of the CRMs. The two horizontal (control) lines are drawn at $\mu \pm 2\sigma$ and $\mu \pm 3\sigma$ on both sides of the mean (μ). Sample values falling beyond $\mu \pm 2\sigma$ indicated a potential out-of-control situation and serves as a "warning" and when sample values fall outside the $\mu \pm 3\sigma$ lines, these values indicate potential existence of an out of control situation for which action may be required. Therefore, the $\mu \pm 2\sigma$ lines are known as warning lines and $\mu \pm 3\sigma$ lines are known as action lines. A sample picked or, tagged as failure or warnings, are selected for further investigations. In this presentation, the use of the control lines and the underlying assumptions will be discussed with a goal to start re-thinking about proper use of these lines. Potential modifications to such charts will also be presented.

3:45 pm

Bulk Ore Sorting Use Cases and Value Using Shovel-Based Sensor Technology in Multiple Ore Types

D. Higgins[2], M. Pal[2] and f. gomez[1]; [1]industry, Tucson, AZ and [2]Industry, Vancouver, BC, Canada

Natural variability of deposits, sparse blasthole sampling, blast movement and multiple ore and rock types can add complexity to any ore control process, causing ore loss and dilution. Improved ore body characterization, mine planning optimization, and blast movement simulation are examples of techniques to help combat these challenges and in turn increase copper production. However, they are usually limited by the scarcity and lack of representativity of input data, relying on in-situ drill hole data. Shovel mounted XRF-based sensors allows for the recognition of the metal content at a much higher resolution than the traditional ore control approaches, refining the inputs for decision-making. Shovel-mounted XRF-based sensors have been installed and used at a Freeport mine on a production P&H4100 electric rope shovel to predict grades at the mine face for the purpose of bulk ore sorting to divert misclassified trucks to their correct destination. Additionally, the technology behind the sensors groups the material in each bucket into the two primary ore types at the mine for a more accurate bucket grade prediction and better ore body characterization.

Monday, February 23
Afternoon

MINING & EXPLORATION: GEOSCIENCE: JOINT SESSION SME/AIPG: EXPLORATION EXCELLENCE: NEW DISCOVERIES AND TECHNOLOGIES

255B

Chairs: ***D. Wolfe****, NACCO Natural Resources, Plano, TX*
J. Brinton*, Agapito Associates, Grand Junction, CO*

2:00 pm

Introductions

2:05 pm

Critical Minerals Mapping Across the United States Under the USGS Earth Mapping Resources Initiative (Earth MRI)

J. Jones; USGS Mineral Resources Program, Anchorage, AK

The USGS Earth Mapping Resources Initiative (Earth MRI) acquires modern geologic, geochemical, hyperspectral, lidar, and geophysical data across the Nation in partnership with State geological surveys and others. Funding from the 2021 Infrastructure Investment and Jobs Act accelerated and expanded data collection, helping the USGS meet a Congressional mandate to map the Nation's below- and above-ground critical mineral resources. Earth MRI is also developing a national mine waste inventory and conducting site-specific characterization activities. This presentation will highlight Earth MRI research, outcomes, and planned directions and will describe opportunities for industry engagement. Data and reports can be found at https://usgs.gov/special-topic/earthmri.

2:25 pm

26-064

Utilization of Magnetic Susceptibility in the Characterization and Mapping of Climax-Type Molybdenum Porphyry Deposits: New Data from the Climax Mine

N. Dworian, A. Smith and I. Kellogg; Freeport McMoRan, Leadville, CO

Many studies have utilized magnetic susceptibility data to fingerprint porphyry copper centers; however, usage of magnetic susceptibility data to identify trends in a Climax-type molybdenum porphyry deposit is limited. To better understand potential petrophysical signatures in a Climax-type Mo porphyry deposit, magnetic susceptibility data was gathered at regular intervals from core holes across the Climax Mine, targeting major lithologies and styles of alteration. Preliminary analysis suggests that there are quantifiable patterns which may correspond with the mineralizing intrusions. This data can complement current mapping and exploration techniques to identify Climax-type molybdenum porphyry centers and likewise further the exploration potential for this deposit type.

2:45 pm

Deep Learning–Driven Hyperspectral Mapping of Critical Minerals: A Case Study from the Northern Mojave Desert, California

J. Habashi[2], I. Masoumi[1] and A. Moradi[1]; [1]University of Kentucky, Columbus, OH and [2]Tabriz university of technology, Tabriz, iran, Tabriz, Iran (the Islamic Republic of)

Critical mineral exploration increasingly leverages orbital imaging spectrometers for remote, high-fidelity mineral surveys. We present an integrated workflow using Earth Surface Mineral Dust Source Investigation (EMIT) data, Adaptive Vertex Component Analysis (AVCA), and a 3D Convolutional Neural Network (3D CNN) to generate mineral prospectivity maps with minimal field input. Applied to the Mojave Desert, AVCA identified 14 spectral endmembers, verified at 30 field stations. This approach reached 95% classification accuracy using a 70:30 spatial training split. The results demonstrate that advanced hyperspectral sensing combined with 3D CNN can effectively map critical minerals across large areas, supporting reliable and cost-effective resource assessments.

3:05 pm

The Potential Impact of Seabed Mining on Critical Mineral Supply Chains and Global Geopolitics

T. LaTourrette; RAND Corporation, Santa Monica, CA

The potential emergence of a seabed mining industry has important ramifications for the diversification of critical mineral supply chains and global geopolitics. This work explored the likelihood and magnitude of their impacts to better inform planning and policymaking. We found that seabed mining presents an opportunity for the United States and its allies to diversify critical mineral supply chains, bolstering critical mineral supply reliability and security; a global seabed mining industry could produce amounts of nickel and cobalt—key elements for lithium-ion batteries—that are equal to the projected U.S. demand in 2040; seabed miners might face fewer barriers to entry into the mining industry than junior terrestrial miners; and the establishment of a seabed mining industry would have geopolitical implications, including shifts among relationships within the Indo-Pacific region, concerns related to regulatory monitoring and enforcement, new territorial disputes, increasing demand for maritime domain awareness and security, and new influences on commodity prices and security of supply.

3:25 pm

Artificial Intelligence: Empowering Professionals in Exploration and Mining

F. Tremblay; Stantec, Pinedale, Wyoming, Afghanistan

Professionals in mining often handle complex datasets requiring both efficient analysis and expert judgment. Artificial intelligence (AI) enhances our ability to analyze large datasets, identify trends, and perform statistical analysis, supporting but not replacing human expertise. Stantec's mining experts actively integrate AI into workflows to support tasks like data evaluation, report drafting, and code generation – freeing up time for in-depth analysis and strategic thinking. However, AI has its limitations. Risks such as errors, bias, and over-reliance must be carefully managed. As technology advances, recognizing both the power and the pitfalls of AI has never been more important. Through real-world examples, this presentation highlights how Stantec integrates AI into its workflows and reinforces the value of using AI to enhance, rather than replace, professional expertise

3:45 pm

Discussion of Temporal Constraints of Source, Trap, and Conduit in LCT Pegmatite Formation for Mineral Systems Exploration

W. Starkel, E. Schrimsher, A. Villhard and D. Norfleet; Albemarle Corporation, Charlotte, NC

Pegmatites enriched in lithium, cesium, and tantalum (LCT) are the highest-grade sources for lithium, a critical element for global energy needs. Recent mineral systems model (MSM) studies for LCT pegmatite exploration focus on identifying source rocks (e.g., S-type granites, mid-to-high grade metapelites), trap lithologies (e.g., amphibolites), and conduits (e.g., regional-scale structures), but have limited discussion on temporal constraints for LCT pegmatite formation. For example, recent literature indicates fractionation-derived pegmatites require coeval emplacement with source granites whereas anatexis-derived pegmatites require sufficient cooling times for source rocks to allow for partial melting to occur. Our findings suggest incorporating detailed reviews of geochronology can aid in MSMs when evaluating prospectivity from district to regional scales. This study attempts to build geochronology guidelines for LCT pegmatite exploration with a focus on timing of source lithologies, trap lithologies, and conduits based on examples in the literature.

4:05 pm

Advanced Implicit Modeling Applications for Multidisciplinary Geotechnical and Resource Geology Projects

J. Marke and D. Loveday; Stantec Consulting Services Inc., Geneva, OH

Implicit modeling techniques are increasingly vital for efficiently characterizing complex subsurface conditions across both civil and mining sectors. This presentation highlights practical applications of 3D geological modeling in projects ranging from earthen dam foundations and contaminated soil impoundments to slope stability assessments, exploration planning, and resource estimation. By integrating diverse geotechnical and geological datasets, these implicit modeling applications support faster decision-making, reduced uncertainty, and enhanced future project planning.

Monday, February 23
Afternoon

MINING & EXPLORATION: INNOVATION & TECHNOLOGY: AUTOMATION, ROBOTICS, AND OTHER INTELLIGENT SYSTEMS IN MINING

Sponsored by Newmont

255F

Chair: ***S. Frimpong****, Missouri University of Science and Technology, Rolla, MO*

2:00 pm

Introductions

2:05 pm

Zero Harm and Higher Efficiency: Readiness, Reception, and Management of Autonomous Haulage Systems in Mining

M. Obosu and S. Frimpong; Missouri University of Science and Technology, Rolla, MO

Autonomous Haulage Systems (AHS) are redefining surface mining operations by enhancing safety, improving efficiency, and minimizing human exposure to hazardous environments. This paper investigates the industry's readiness for AHS adoption, evaluates the reception of these systems by operators, and supervisors, and analyzes the technological and operational control mechanisms that support AHS deployment. Using case studies and recent implementations, the study outlines safety improvements, productivity gains, and cost reductions enabled by AHS. It also addresses key challenges, including infrastructure requirements, change management, regulatory compliance, and interoperability. The findings underscore AHS as a strategic enabler of zero harm and sustainable mining performance.

2:25 pm

26-026

Digital Transformation and Generative AI for Sustainable Decision-Making in Mining

A. Soofastaei; The University of Queensland, Chapel Hill, QLD, Australia

This paper presents real-world case studies from Newmont and Vale to demonstrate how digital transformation and generative AI can drive sustainable decision-making across the mining value chain. By integrating advanced analytics, AI-driven simulations, and digital twin technologies, both companies achieved measurable improvements in productivity, safety, and environmental performance. At Newmont, predictive modeling and autonomous systems enabled more efficient resource utilization and emissions reduction. At Vale, generative AI supported real-time decision-making for equipment maintenance and energy optimization, contributing to multimillion-dollar annual savings and enhanced operational sustainability. This study highlights the strategic role of AI in enabling responsible mining by linking data-driven insights with tangible outcomes. Practical frameworks and lessons learned are shared to guide future digital initiatives in the mining sector.

2:45 pm

The Human Edge in Autonomous Mining: Designing for Operators, Not Replacing Them

M. Popova[1] and C. Blignaut[2]; [1]Epiroc Rock Drills AB, Örebro, Örebro län, Sweden and [2]Epiroc Drilling Solutions LLC, Garland, TX

Remote and autonomous operations continue to expand in surface mining, bringing productivity and efficiency gains. Our team explores key elements of modern human–machine interface and control room platform design—aiming to empower, not replace, operators. We emphasize the need for intuitive, adaptive systems that support real-time decision-making while addressing risk factors tied to communication and operational failures. Recognizing that automated technologies demand new skill sets, we prioritize reducing psychological stress rather than introducing new burdens. Our goal is to support safer, more resilient, human-centric remote center environments that align with the operators' evolving role in autonomous drilling and beyond.

3:05 pm

Advancing Mine Safety and Productivity with Fleetwide, Retrofit Automation

E. Pohlmann; Nerospec SK USA Corp., Fairview, PA

As the mining industry advances toward autonomy, Vehicle Intervention Control (VIC) emerges as a foundational enabler, connecting safety, compliance, and automation maturity. Nerospec SK's VIC system delivers EMESRT Level 9 functionality, capable of autonomous braking or course correction when operators fail to respond, reducing the risk of high-consequence incidents involving mobile equipment. OEM-agnostic and interoperable with various PDS providers, Nerospec SK's Vehicle Intervention Control (VIC) system has been deployed in over 3,000 machines across underground and surface operations. Beyond preventing collisions, VIC prepares fleets for higher levels of automation by enabling direct machine control, edge computing, and integration with tele-remote or centralized fleet systems. By reducing unplanned downtime and improving Overall Equipment Effectiveness (OEE), especially during shift changes or re-entry delays, VIC not only enhances safety but also delivers measurable productivity gains. Nerospec SK demonstrates how Level 9 Vehicle Intervention Control can accelerate the mining industry's journey toward autonomous, high-performance, and incident-free operations.

3:25 pm

Mining the Failures: LLM-Assisted Clustering of Product Failure Reports

R. Strom and R. Sroda; Komatsu, Barrington, IL

Identifying quality issues in mining equipment is challenging due to wide geographic range, small machine populations, complex products, and open-ended textual data. Addressing this challenge we have demonstrated how we can leverage LLM models to summarize complex failure case data, provide guidance on case severity and provide end users feedback on data quality. Combining LLM model outputs with traditional ML methods such as probabilistic clustering have demonstrated the ability to identify hidden product issues. When these analytic insights are integrated within existing product support software and processes, we have shown the potential for significant reduction in time to issue resolution.

3:45 pm

Autonomous Haulage - The Biggest Paradigm Shift in Mining Safety

J. Humphrey; Independent Consultant, Decatur, IL

Autonomous haulage has been commercially implemented in multiple countries for about two decades. With over a 1000 large mining trucks running autonomously worldwide, the safety implications are become clearer and the data more robust. Autonomous Haulage is showing clear safety improvements, not just for trucks but for other machine that interact with truck. The author pulls together multiple data streams into a cohesive picture of the clear safety case for Autonomous Haulage.

4:05 pm

Robust Coal Miner Detection in Underground Mining Environments: Model Capacity, Augmentation, and Condition-Aware Thresholding Optimization Under Challenging Conditions

E. Essien and S. Frimpong; Missouri University of Science and Technology, Rolla, MO

Real-time miner detection in underground environments faces challenges from lighting variations, occlusions, blur, and diverse camera angles. Existing YOLO methods achieve high validation accuracy but rarely assess camera viewpoint or occlusion robustness, relying on validation mAP that fails to predict real-world performance. This study develops a comprehensive YOLO11 evaluation framework across 11 conditions, emphasizing multi-angle and occlusion robustness with adaptive confidence thresholding that adjusts detection sensitivity based on viewing angles and environmental conditions. Results show validation mAP fails to predict deployment performance: YOLO11s-Baseline achieved the highest mAP (98.10%) while YOLO11n-Enhanced with the lowest mAP (97.07%) delivered superior deployment performance (1.384), outperforming larger models across low-light, blur, occlusion, and multi-angle scenarios. Side-view images required 26% lower thresholds; occlusion reduced performance by 35%. Enhanced augmentation with adaptive thresholding improved robustness by 3%, validating that the augmentation strategy and condition-aware processing surpass model capacity for safety-critical mining deployment.

Monday, February 23 Afternoon

MINING & EXPLORATION: MANAGEMENT: LAND MANAGEMENT & REGULATORY COMPLIANCE

255C

Chair: ***M. Teply****, Rio Tinto Kennecott*

2:00 pm

Introductions

2:05 pm

Proactive Detection, Responsible Operations: The Evolution of SO2 Monitoring at RTK

A. Keough; Rio Tinto, South Jordan, UT

This comprehensive overview explores the dynamic evolution of sulfur dioxide (SO2) gas leak detection methods within sulfuric acid plants, with a focus on historical and modern techniques applied to Rio Tinto Kennecott's (RTK) Acid Plant and the smelter gas train. The historical progression from simple chemical indicators to sophisticated electronic detectors, including autonomous optical gas imaging (OGI), and AI-powered infrared imaging technology is examined in the context of proactive care and maintenance, environmental stewardship and good neighbor practices, utilizing emerging technology to minimize industrial impacts on local communities, and a need to stay well informed of the available resources industry can use to characterize impacts.

2:25 pm

How Close Is Too Close? Balancing Mining Operations and Urban Expansion

C. Norman; Rio Tinto, South Jordan, UT

With residential growth pressing up against the Bingham Canyon Mine, our team at Rio Tinto Kennecott set out to define how we can responsibly manage land on the edge of one of the world's longest-running mining operations. This session walks through the process used to define both operational and post-closure land buffers for property located in the southwest corner of the Salt Lake Valley—an area with high development interest and strategic value. The presentation will touch on various quantitative and qualitative considerations that were weighed to manage risks, community expectations, and long-term mine planning. The result is a buffer strategy that protects our ability to operate while opening the door for thoughtful, phased development. This session offers practical insights for mining professionals managing land use at the urban interface.

2:45 pm

Barneys Canyon Gold Mine Closure

T. Heaton; Rio Tinto, South Jordan, UT

This session describes various lessons learned during closure of the Barneys Canyon Gold Mine from 2001 to 2020. In this session we will discuss Barneys Canyon gold mining and how it relates to closure planning and execution. Environmental management, reclamation challenges, reclamation techniques, and regulator partnerships will be discussed.

3:05 pm

Remediation Across Active and Legacy Operations at the Kennecott Superfund Site

D. Sheumaker; Rio Tinto, South Jordan, UT

The Kennecott South and North Zones represent one of the most complex remediation efforts in the western United States, with overlapping regulatory frameworks, legacy contamination, and ongoing mining operations. This presentation will outline the multi-decade strategy for soil and groundwater remediation at the site, focusing on the evolution of remedy design under CERCLA oversight. Specific emphasis will be given to plume delineation, remedy refinement, and coordination with state and federal regulators. Case studies from the South Zone (Superfund Alternative Program) and North Zone (proposed-NPL) will highlight adaptive management strategies, integration of institutional controls, and lessons learned from realigning with updated risk-based standards and land use goals.

3:25 pm

Rio Tinto Kennecott South End Groundwater Remediation Progress

E. Naran; Rio Tinto, South Jordan, UT

Since 1986, the EPA has investigated groundwater contamination in the Southwest Jordan River Valley, identifying two plumes near the Bingham Canyon Mine. The primary focus, Zone A (the acid plume), contains low pH and elevated metals. Rio Tinto Kennecott (RTK) began remediation in collaboration with the EPA and UDEQ, formalized in a 2008 consent decree. The plan includes plume containment, acidic water extraction and neutralization, treatment management, stakeholder engagement, and ongoing monitoring. RTK has significantly reduced the plume's impact through sustained remediation efforts. This presentation outlines progress, operational controls, and monitoring activities at the South Facilities.

Monday, February 23 Afternoon

MINING & EXPLORATION: MANAGEMENT: RISK MANAGEMENT

250E

Chair: ***D. Kijewski****, Stantec, Surprise, AZ*

2:00 pm

Introductions

2:05 pm

26-008

An Integrated Framework for Scenario Sensitivity Analysis

R. Sousa[1] and G. De Tomi[2]; [1]Cirrus Mining Innovation | Quartex, Denver, CO and [2]University of Sao Paulo, Sao Paulo, Sao Paulo, Brazil

Whilst all public mineral reporting codes require classification of mineral resource and reserves according to the level of geological knowledge and confidence of the estimates, companies are not required to disclose how mineral estimates and associated cashflow projections respond probabilistically to the incorporation of different types of risk events. As the level of expectations and scrutiny of investors and stakeholders continue to increase over the years, it will be essential for companies to adopt an integrated framework for sensitivity analysis to increase corporate value through better capital allocation and reduce potential losses associated with poor investment decisions. Failure in fully capturing the impact of unexpected incidents in mineral estimates and financial modeling could be extremely harmful to the business, affecting the company's reputation, and negatively impacting the relationship with stakeholders.

2:25 pm

26-054

Risk Management for Surface Mine Sites Using Geotechnical Monitoring

E. Rose; Barr Engineering Co., Salt Lake City, UT

The concept of risk management can be applied to multiple aspects of the mining lifecycle including safety, mine design, business plan—anything that affects getting the ore to the mill for production. This talk reviews the importance of managing risk when operating in surface mine sites. A high-level overview of development practices, levels of risk, and risk tolerance will be provided. Further detail will be provided on typical monitoring practices, types of instrumentation, and how to communicate what data are showing to key stakeholders. Case studies will be shown as examples of utilizing instrumentation to collect data for operational safety.

2:45 pm

Optimizing Mine Facility Performance through Effective Commissioning Practices

N. Marcello; WestLand Resources, Tucson, AZ

Commissioning is often not seen as an integral part of the mining process. However, effective commissioning contributes to better system performance, reduced risk, and lower overall lifecycle costs for mining operations. Investing in early-stage inspection, verification, and validation helps to avoid startup issues, reduce downtime, and enhance safety and productivity across complex systems. This presentation discusses real-world results from multiple mining sites, showcasing tangible benefits such as accelerated startup, fewer operational disruptions, and improved reliability. These examples demonstrate that commissioning is not just a final step, but a critical investment that delivers lasting value throughout a facility's operational life.

3:05 pm

Importance of Conducting Pre-Blast Surveys for Site and Structures to Help Ensure Operational Success

D. Schnell, J. Calnan and Z. Agioutantis; University of Kentucky, Lexington, KY

Pre-blast surveys are an integral part of ensuring the success of every blasting operation. Pre-blast surveys take many different forms, from gathering site-specific field data for blast optimization to creating a positive relationship with community through surveys of residential structures. Adequate site-specific information allows the blast technician and engineer to properly plan and execute blasts to ensure the safety of the public and operation while maximizing blast performance. Surveying residential structures allows a site to build a relationship with the community, answer any questions they may have, and protect both the home owner and operation. Well planned and executed pre-blast surveys help operations to be set up for success. Important aspects of various types of pre-blast surveys will be reviewed and discussed based on a review of literature and case studies.

3:25 pm

Dozer Trim Mitigation in Geotechnically Sensitive Zones: A Case Study from Bingham Canyon Mine

S. Barcelona; Rio Tinto, South Jordan, UT

The OSR remediation project at Rio Tinto's Bingham Canyon Mine addresses a geotechnically sensitive zone impacted by a legacy slide and active ore mining below. This mitigation effort focuses on dozer trim strategies to enhance slope stability and enable safe, continued mining. Key functional aspects include projecting timelines for dozer trims, evaluating shovel access in constrained areas, and coordinating across geotechnical, operations, and planning teams. The project highlights the challenge of balancing economic efficiency with geotechnical integrity and operational feasibility. Outcomes and lessons learned will inform future remediation efforts in similarly complex mining environments.

3:45 pm

26-053

Reputation Engineering: Building Stakeholder Trust in the Age of AI

M. MacMillan; PRA Communications, Vancouver, BC, Canada

In today's AI-powered information landscape, mining companies are being defined by algorithms - before they even speak. From investors using ChatGPT to regulators searching online, reputations are shaped in real time and with or without direct input. This session provides a practical, data-informed roadmap for building a modern mining reputation in an era of scrutiny, speed, and compressed attention spans. Learn how digital visibility, technical storytelling, and proactive communication drive stakeholder trust and project momentum. Attendees will see why silent or reactive strategies risk real costs - lost capital, slower permits, or missed talent - and how others are using communications as a strategic lever.

Monday, February 23 Afternoon

MINING & EXPLORATION: OPERATIONS: JOINT SESSION: SME UNDERGROUND VENTILATION COMMITTEE: VENTILATION MANAGEMENT CASE STUDIES

255E

Chairs: ***J. Almgren****, Spendrup Fan Company*
D. Brokering*, Freeport McMoRan, Littleton, CO*

2:00 pm

Introductions

2:05 pm

26-006

Airflow Distributions with Ventilation Borehole, Fan and Curtains for Large Opening Mine Through Field Study and CFD Modeling

X. Song and S. Liu; Penn State, State College, PA

To investigate the influence of ventilation boreholes, fans, and curtains for large opening underground mines (LOUM), we conducted a field survey for LOUM with the survey data serving as the numerical modeling inputs using computational fluid dynamics (CFD) models. Five different CFD modeling results were obtained with different setting conditions. The results indicate that most air quantity directly escapes through outlet 1 after coming into the inlet, causing a huge loss of airflow; volumetric air exchange index (VAEI) is proposed to measure air exchange efficiency, with zone 2 of case 5 having the highest VAEI; The ventilation borehole minimally affects zones 2-4, but drastically alters airflow direction in zone 1; The box fan enhances airflow to zone 2, improving ventilation efficiency; Curtains have little effect on distant working faces but influence airflow near inlets and outlets; Recirculation and vortices mainly form in the channels closest to the channel where the inlet is located. This study provides a foundation for future research on the influence of ventilation boreholes, fans, and curtains, as well as optimizing their placement and effectiveness in face ventilation.

2:25 pm

Assessment of Dust Allayment Systems for Application in the Underground Mine Environment

J. Fox[1], J. Miller[2], A. Greth[1] and J. Bowling[1]; [1]SRK Worldwide, Vancouver, BC, Canada and [2]ICL Group, Cleveland, Loftus, Saltburn, United Kingdom

To reduce hazardous dust concentrations and satisfy new regulations (such as MSHA's new silica rule), many new, increasingly complex dust allayment systems have been proposed. Roadway treatment options exist to help allay airborne dust, especially silica, in underground workplaces but special considerations must be addressed, for example, in operations that excavate evaporate minerals. Other systems include the use of dry dedusting fans and dry water mist curtains have been employed with varying degrees of success. These and other low-tech dust control measures should be evaluated on a site-by-site basis. Mineralization interactions presented by dust allayment systems yielding potential pitfalls should be simulated with pilot tests to eliminate operational risks. Many other airborne and site generated dust sources should also be addressed at the source to provide maximized efficiency in the overall ventilation plan. This review evaluates the current dust allayment systems to provide practical guidance for their implementation in underground mines.

2:45 pm

Parallel Fans and Operational Stability

A. Peltier and J. Almgren; Spendrup Fan Company, Grand Junction, CO

When designing a parallel fan system care must be taken in the analysis to ensure stable operation of Vane Axial fans. Hagan Line Analysis is a graphical method used to evaluate the performance of fans operating in parallel during startup in the case where each fan is brought on-line in a consecutive manner. It helps assess stability of the last fan by comparing individual fan performance within the parallel system. A key parameter in this analysis can be described as the Minimum Stall Pressure. This value cannot be accurately determined without adequate fan testing, as it is influenced by several variables—including blade angle, hub ratio, and overall fan configuration. These variables must be carefully considered, as they significantly affect fan behavior and system performance. This presentation will outline some factors to consider when designing a parallel fan system.

3:05 pm

Operational and Maintenance Challenges of Mine Cooling Systems at Hecla Mining Company's Lucky Friday Mine

J. Deen; Deen Engineering LLC, Livingston, MT

Hecla Mining's Lucky Friday Mine requires 6.8 MWR cooling capacity as operations extend to 2.5 km depth. The initial 3.4 MWR system commissioned in 2014 includes a Central Refrigeration Plant (CRP) on 4900L serving bulk air coolers (BAC) on 5900L and 6500L levels, plus #4 shaft coils. By 2023, both BACs showed suboptimal performance due to extensive fouling from fugitive dust accumulation on air-side heat transfer surfaces—a common underground mining challenge. This paper documents maintenance practices implemented over two years to extend coil service life and presents improved coil designs with increased fin spacing for more effective cleaning in harsh mine environments.

3:25 pm

Enhancing Mine Ventilation Efficiency Through Fan Law Application

E. Fagley; Tata Chemicals, Green River, WY

Optimizing axial vane fan performance can significantly improve mine ventilation efficiency. This study examines adjustments to blade pitch settings in conjunction with variable speed drives, leveraging fan laws to match airflow requirements while minimizing energy consumption. Field implementation in an underground mining environment resulted in measurable reductions in power demand, operating costs, and noise levels at the fan. The methodology demonstrates how targeted fan parameter modifications can achieve sustainable ventilation without compromising safety or production. These findings provide a practical framework for mining operations seeking to improve ventilation efficiency, reduce environmental impacts, and enhance workplace conditions.

3:45 pm

26-057

Smart Air in the Underground Mine: Advancing Real-Time Ventilation Monitoring in Humid Underground Mines

F. Günther, M. Friedemann and H. Mischo; TU Bergakademie Freiberg, Freiberg, Sachsen, Germany

Ensuring adequate ventilation is a critical aspect of safety in underground mining operations. In small-scale mines in particular, key ventilation parameters such as temperature, humidity, and air velocity are often measured manually and only at infrequent intervals, typically using analog instruments. As a result, real-time monitoring of environmental changes, timely detection of hazardous situations, and demand-driven ventilation control are not feasible. This presentation discusses the selection and evaluation of modern digital ventilation measurement devices, including handheld instruments with digital data logging capabilities and continuously operating sensors with potential for real-time data transmission. The investigations focus on the challenges posed by underground environments with extremely high humidity levels, which can adversely affect sensor performance and electronic components. The results are based on testing conducted at the Research and Teaching Mine of Freiberg University – an ore mine characterized by humidity levels exceeding 95 %. Findings include assessments of measurement accuracy, reliability, and practical applicability under these demanding conditions.

Monday, February 23
Afternoon

MINING & EXPLORATION AND RESOURCES & RESERVES COMMITTEE: S-K1300 IN PRACTICE

155F

Chairs: ***D. Hulse****, Forte Dynamics, Inc*
J. Young*, Freeport-McMoRan Inc, Phoenix, AZ*

2:00 pm

Introductions

2:05 pm

SME SK1300 2025 Survey

J. Young; Freeport-McMoRan Inc, Phoenix, AZ

Summary of the results of the 2025 SME Survey for Implementation and Compliance with Regulation S-K 1300.

2:25 pm

Review of SEC Comment Letters on S-K1300 Compliance

S. Searston[1] and G. Gosson[2]; [1]Mine Technical Services, Parker, CO and [2]WSP, Vancouver, BC, Canada

The industry is fortunate in having the SEC publicly file comment letters on review of S-K1300 disclosure and benefits from understanding the types of compliance issues that are raised. Comment letters filed since the introduction of S-K 1300 were reviewed. Categories of non-compliance were identified. This paper will present the review results, causes of non-compliance, and what was required to resolve identified issues. The categories that are covered include: exploration properties; mineral resource and mineral reserve estimates; mining studies; technical report summaries; marketing studies; economic analyses; Qualified Persons; reliance on the registrant; summary and material property disclosure; internal controls disclosure.

2:45 pm

Reserves and Resources Reporting in the Construction Aggregate Industry After SK-1300

F. Lieth; Vulcan Materials Company, Birmingham, AL

The change to reserves and resources reporting after the implementation of SK-1300 has impacted the various mined commodities differently. For the publicly traded construction aggregate companies, the specific changes have mostly led to a significant improvement in transparency and clarity about the assets that underlay the value of the company. In addition to the value to the investors, it has also increased for the company as it has sharpened the accuracy as a planning tool. This is a discussion of challenges faced, decisions made, and changes implemented on the road to full compliance.

3:05 pm

Effects of S-K 1300 on US Coal Reserve Values

B. Groff; Groff Engineering & Consulting LLC, Mt. Sterling, KY

This presentation reviews and discusses US coal company statistics since January 1, 2021, when compliance with Regulation S-K 1300 was initiated. The first technical report summaries were published in 2022. The discussion includes a review of the technical reporting, geopolitical events, and US market capitalization per ton of reserves. As the intent of S-K 1300 was to place US registrants on a level reporting standard as foreign registrants, the presentation will review how the US has fared in reaching its goal.

3:25 pm

What Do You Mean These Regulations Cover Industrial Minerals?

P. Christensen and C. McCannon; RESPEC, Littleton, CO

A casual read of the S-K 1300 regulations may lead you to think they feel they are metals and possibly coal centric. However the value of industrial minerals produced in the USA in 2024 was greater than that of metals and coal combined? Given how important industrial minerals are to the economy of any nation and the need for public or private investment to ensure their availability, getting a handle on how the S-K 1300 regulations apply to these deposits is important. This presentation will unpack the regulations from the perspective of the geologist, engineer or other professional tasked with estimating and reporting resources and reserves how they are being applied to industrial minerals.

3:45 pm

Supporting Novel Processing Options in a Technical Report Summary

J. Sorensen[2] and W. Tyler[1]; [1]McEwen Copper Inc, Dillon, CO and [2]Samuel Engineering, Greenwood Village, CO

New technology development is moving rapidly in the mining spectrum aimed at better project outcomes economically, environmentally and improved sustainability. Including this new technology or application in a SK-1300 compliant Technical Report Summary (TRS) has a few challenges. Specifically, if the processing method, plant design, or other parameter has never been used to commercially extract the valuable product from such mineralization and is still under development, then no mineral resources or reserves can be disclosed on the basis of that method, design, or other parameter. The fundamental question is "how novel is novel" in terms of investment risk to shareholders. In many cases, adaptations or versions of the technology or equipment combinations have been commercially practiced, however the methodology in total or combination may not have a specific commercial reference. To include a novel method, there must be a "demonstration of economic viability" relative to the level of study and the apparent risk and the application to the project. Disclosure of elements of the process may be particularly challenging due to the Intellectual Property.

4:05 pm

Lessons Learned in Aligning Mineral Resource and Reserve Reporting Across Jurisdictions: Insights from AngloGold Ashanti

T. Flitton[2], M. Godoy[2] and A. Eliot[1]; [1]Geological Society of South Africa, Johannesburg, South Africa and [2]SME, Englewood, CO

The global mining industry is moving toward greater alignment of public reporting standards for Mineral Resources and Mineral Reserves, driven by CRIRSCO-aligned codes such as SAMREC, as well as regulators such as the SEC. While these frameworks share principles of transparency, materiality, and competency, differences in structure and disclosure requirements require careful integration for companies operating across multiple jurisdictions. SAMREC and S-K 1300 are broadly aligned but differ in reporting detail and presentation, with S-K 1300 introducing a structured framework and elements such as the Technical Report Summary. For companies with dual or multiple listings, understanding these frameworks is essential for consistent and compliant reporting. AngloGold Ashanti (AGA), a global gold mining company, provides a practical example of this process. AGA's strategy integrates both frameworks, supported by a cloud-based reporting system with built-in validation and efficient data consolidation. This study highlights AGA's experience in aligning SAMREC and S-K 1300, showing how a data-centric approach can reduce reporting burdens while ensuring transparency and integrity.

4:25 pm

Keeping A Technical Report Summary Current

S. Searston[1] and G. Gosson[2]; [1]Mine Technical Services, Parker, CO and [2]WSP, Vancouver, BC, Canada

Registrants must assess their technical report summaries at fiscal year end, and review the material assumptions and scientific and technical information. Forward-looking information must have a reasonable basis, which includes the inputs and assumptions used. If the previously filed report is not current in these material respects, the registrant must file a revised or new technical report summary. The current global volatility affects many assumptions, including the level of mining study, exchange rates and commodity pricing, and product supply and demand. There are steps that issuers can take to mitigate these uncertainties to keep the information current longer.

Monday, February 23 Afternoon

MPD: PLENARY SESSION

Grand Blrm D

Chairs: ***A. Noble****, Virginia Tech, Blacksburg, VA*
A. House*, Paterson & Cooke, Helena, MT*

2:00 pm

Introductions

2:05 pm

Particles and Froths for Fun and Profit - Antoine M. Gaudin Award Lecture

J. Cilliers; UMIST Chemical Engineering Sr Lecturer, UMIST Chemical Engineering, Manchester, United Kingdom

Over the past 25 years, Jan has witnessed—and helped shape—some of the most exciting advances in flotation and physical separation. He realized early on in his career that to be successful, academic research must add financial value to the industry. Three examples, two on flotation and one on hydrocyclones, will show how fundamental science and modeling translated into economic impact on the plant. The bumpy path from lab to plant will be illustrated with pictures and videos of particle tracking using PET scanners, CFD models and 3-D printing, and tales of frustration and elation. Finally, a glimpse at a future beyond flotation will touch on dry mineral processing and lunar mining and demonstrate a novel electrostatic particle separator.

2:35 pm

Learning and Good Fortune on the Road to Discovery - Robert H. Richards Award Lecture

R. McIvor; Metcom Technologies, Marquette, MI

Sharing knowledge is a hallmark of the minerals business. It provides those it employs with vast opportunity for learning and problem solving. By a fortuitous sequence of working experiences, I was trained in the application engineering of first, slurry pumps; secondly, grinding mills; and thirdly, hydrocyclones. I learned from some of the world's leading experts in those fields. This led to a sudden personal enlightenment, literally a "eureka moment," about how these three interact to determine the productivity of any grinding circuit. With the overwhelming support of others, I was enabled to develop, expand and deliver this important new knowledge back into the business that was the origin of its inspiration.

3:05 pm

In the Pursuit of Happiness - Leveraging Curiosity to Deliver Value - Milton E. Wadsworth Award Lecture

R. Kappes; Newmont, Englewood, CO

The successful application of technology in the mining industry remains a challenging endeavor. Core to any successful technology application is a robust understanding of the system being impacted, a strong value proposition and productive change management. This presentation describes key learnings gathered from a career in the gold mining industry that have successfully been leveraged to deliver value.

Monday, February 23 Afternoon

RESILIENT ENERGY IN MINING: BALANCING TRADITION AND TRANSFORMATION: HARNESSING GREEN MINING: SUSTAINABLE AND RESILIENT SOLUTIONS FOR THE ENERGY TRANSITION

Grand Blrm B

Chairs: ***E. Vahidi****, University of Nevada Reno, Reno, NV*
D. Reed*, Idaho National Laboratory Research Library, Idaho Falls, ID*

2:00 pm

Introductions

2:05 pm

Obtaining & Maintaining Social Acceptance: Lessons from Eagle Mine, Michigan

M. Morrison[2], K. Moffat[3] and A. Coppel[1]; [1]Pacha Associates, Arlington, VA; [2]Lundin Eagle Mine, Big Bay, MI and [3]Voconiq, Bowen Hills, QLD, Australia

The Eagle Mine (Michigan) exemplifies how to move from near failure due to opposition to social acceptance. Eagle's experience provides replicable lessons on how to build trust and legitimacy through a data-informed, proactive approach to community engagement. The use of the Social License to Operate (SLO) Index—a tool that goes beyond traditional support/opposition polls and perception surveys – has been key, capturing how communities experience the site. It focuses on procedural fairness—i.e. if people feel they are treated with respect, have a genuine voice in decisions, are subject to fair and unbiased processes, and receive transparent communication backed by consistent action. The mine's strategy to maintain trust includes independent environmental monitoring, public tours, open feedback, local workforce development, and partnerships; all are refined using SLO Index data, which helped the company secure a sustainability-linked loan tied to measurable levels of community acceptance. In today's pressure to develop mines, Eagle validates that social acceptance hinges on ongoing engagement, data-led insight, and sustained commitment to fair and respectful community relationships.

2:25 pm

Life Cycle Assessment as a Key Tool for Assessing Mining Sustainability and Resilience

J. Dunn and J. Trost; Northwestern University, Evanston, IL

Life cycle assessment (LCA) holistically quantifies the environmental impacts of a product or process from cradle to grave. In a recent review of 75 LCAs of critical minerals mining, however, we determined that LCA methods are applied inconsistently, often using outdated or otherwise low quality data. These LCAs generally exclude key stages of a mine's life cycle including closure and reclamation. In addition, many LCAs do not address environmental effects of mines beyond energy consumption and greenhouse gas emissions, including water consumption. Combining climate change projections and projections of lithium and copper mining in the US, we will illustrate why addressing water consumption in LCA is critical. Robust methods are also essential to enable LCA results comparable across mines – even mines in planning stages - ideally in sustainability frameworks like IRMA that currently do not take a life-cycle approach. We present two case studies for proposed mines in Minnesota to demonstrate LCA's effective use within a mine to prioritize decarbonization opportunities and enhanced sustainability and across mines for differentiated sustainability.

2:45 pm

Resilient Bio-Based Platform for Critical Metal Recovery and Energy-Efficient Mining

J. Urbina; Infinite Elements Inc., El Paso, TX

Infinite Elements Inc. has developed a modular biometallurgical platform that enables metal recovery without the need for new mining. Our BioDissolve™ and BioCapture™ processes extract and concentrate critical metals such as copper, cobalt, gallium, and rare earths from industrial waste, end-of-life electronics, and tailings. These same tools can be applied to primary mining operations to reduce comminution energy, minimize environmental impact, and accelerate production timelines. By replacing high-heat and chemical-intensive methods with biology-based alternatives, this approach supports ESG-aligned mineral development while building resilient, domestic supply chains for the energy transition. Pilot-scale validation has demonstrated scalability across diverse feedstocks, and our co-located systems offer flexible deployment in both developed and remote regions. This presentation will also address how circular recovery pathways can extend mine life, reduce liabilities, and unlock stranded value in waste.

3:05 pm

Lanthanide Sulfate Recovery by Enhanced Pressure Dimethyl Ether (DME) and Synergistic Na2SO4 Fractional Crystallization

C. Tolbert[1], C. Stetson[1], D. Prodius[2], C. Orme[1], D. Appy[3], I. Nlebedim[2] and A. Wilson[1]; [1]Idaho National Laboratory, Idaho Falls, ID; [2]Ames National Laboratory, Ames, IA and [3]TdVib LLC, Boone, IA

Lanthanides are important to many technologies including magnets used in high efficiency traction motors. While common in the environment and industrial waste streams, lanthanides are often present at very low concentrations. This presentation will discuss the lanthanide recovery from an aqueous magnet leachate and mining solutions to single ppm concentrations using a synergistic combination of Na2SO4 addition and subsequent dimethyl ether fractional crystallization (DME-FC) treatment or DME-FC at elevated pressures. It was found that combining DME-FC with low concentrations of Na2SO4 (~0.1 M) results in synergistic isolation of lanthanides while making use of Na2SO4, an excessive byproduct of hydrometallurgical metal production. Combined Na2SO4 + DME reduced lanthanide metal ion's (Pr, Nd, Sm, Gd, Dy, and Ho) solubilities by 1,000-25,000x with final concentrations ranging from 2ppm to 200ppm. The presentation will also discuss the recovery of battery salts from solutions and critical materials from seawater with DME FC as well as the drying of critical material slurries and byproducts using DME as a liquid desiccant.

3:25 pm

Ammonium Sulfate from Phosphogypsum: Assessing the Environmental Impacts of Manufacturing

Y. Yao and F. Zhao; Purdue University, West Lafayette, IN

The global phosphate industry produces more than 150 million tons of phosphogypsum (PG) each year. The phosphate firms are under significant pressure to rapidly identify applications for PG. A research team from Florida Polytechnic Unversity discovered an innovative technique to repurpose PG as a feedstock to produce ammonium sulfate. This study utilizes Life Cycle Assessment (LCA) to analyze the environmental implications of manufacturing ammonium sulfate from this PG. In comparison to traditional methods of industrial ammonium sulfate production, ammonium sulfate derived from PG demonstrates significant reductions across all categories, particularly in high-impact areas such as Global Warming (84%), Freshwater Ecotoxicity (99%), and Non-carcinogenics (98%). Therefore, the manufacturing of ammonium sulfate from PG demonstrates significant promise for advancing green mining initiatives.

3:45 pm

The U.S. Needs a Balanced Policy to Provide Affordable, Reliable, and Abundant Energy that Satisfies Economic, Environmental, and National Security Objectives

D. Struhsacker; Struhsacker Consulting, Reno, NV

Energy and mineral security are essential to national and economic security and to respond to skyrocketing demands for electricity to power AI, manufacturing, EVs, and other uses. U.S. energy policies must recognize there is no uniform, nationwide blueprint for the best way to provide clean, reliable, and affordable energy. The singular focus on reducing CO_2 emissions by replacing baseload coal and natural gas power generation with intermittent wind and solar has weakened grid reliability and created national security and economic threats. Goals to minimize CO_2 emissions must be balanced with the national security and economic imperatives to maintain and improve grid reliability and energy abundance and affordability. Although wind, solar, and battery storage can be part of the energy mix, these intermittent energy sources cannot replace fossil fuel power generation or satisfy the nation's demand for reliable and affordable energy. This presentation will review President Trumps' and Congress' policies to achieve U.S. energy and minerals dominance based on an "all-that-works" energy perspective that balances economic, reliability, environmental, and national security objectives.

Monday, February 23 Afternoon

SME YOUNG LEADERS: PROFESSIONAL DEVELOPMENT

Sponsored by RioTinto

155E

Chairs: ***V. Srivastava****, Freeport McMoRan, Tucson, AZ*
Z. Cicek*, Freeport-McMoRan, Thatcher, AZ*
A. Soni*, Freeport-McMoRan, Marana, AZ*

2:00 pm

Introduction

2:05 pm

Transforming Global Mining Leadership: Excelling in Remote & Hybrid Teams

G. Bermúdez; Metso Canada Inc, Sudbury, ON, Canada

The mining industry is undergoing a major transformation, driven by global shifts and digital innovation. Remote and hybrid work models are now standard, challenging traditional ideas of teamwork, communication, and leadership. Professionals are no longer confined to offices or sites-based enviroments. Nowadays, teams can be distributed across several locations, time zones, and cultures. For young leaders, this presents both a challenge and an opportunity: Maintaining cohesion and productivity while pioneering more flexible, inclusive leadership styles. Agility, empathy, and digital fluency are now essential. This presentation explores key strategies for leading in global, remote and hybrid mining environments. Drawing from real-world experience, it highlights skills like digital communication, trust-building, inclusive decision-making, and mentoring. It also covers tools to drive engagement, accountability, and innovation - whether leading virtual engineering teams, coordinating field operations, or managing cross-functional projects remotely.

2:25 pm

Critical Minerals Leadership Academy: Building a Cross-Disciplinary Workforce for the Evolving Critical Minerals Sector

T. Childress[1], E. Phillips[2], P. Tomski[3], S. Montross[4] and J. Mullen[5]; [1]National Energy Technology Laboratory, Morgantown, WV; [2]University of Wyoming, Laramie, WY; [3]ENTECH Strategies, LLC, Washington, DC; [4]National Energy Technology Laboratory, Albany, OR and [5]National Energy Technology Laboratory, Pittsburgh, PA

The Critical Minerals Leadership Academy (CMLA) is an intensive, week-long professional development program designed to cultivate the next generation of leaders in the U.S. critical minerals (CM) sector. Based in Laramie, Wyoming, the pilot program was sponsored by the U.S. Department of Energy and hosted by the University of Wyoming School of Energy Resources. Assembling graduate students and early-career professionals, CMLA will develop a cross-disciplinary workforce equipped to address technical, economic, environmental, policy, and social challenges in domestic CM development. This inaugural event will foster a national network with systems-level insight and accelerate development of the domestic CM sector.

2:45 pm

Talent Acquisition at MINEXCHANGE: Building the Future of Mining

M. Martinez-Burns; Caterpillar, Tucson, AZ

With mining jobs in high demand across the U.S. in 2025, driven by the need for critical minerals powering electric vehicles and renewable energy systems, our company is using innovative strategies to stay top-of-mind with the industry's best talent. MINExchange offers a high-impact platform to connect with emerging and experienced professionals, including over 800 attendees expected at the Student and Young Leader Center. By engaging with top talent, promoting career opportunities, and aligning with industry partners, we support long-term hiring goals and business growth, ensuring we attract, engage, and retain the people who will power the future of mining.

3:05 pm

Software Tools & Tech: Empowering the Mining Industry

V. Kona; Vulcan Materials Co, Brentwood, NH

This abstract explores the transformative impact of cutting-edge software and technological solutions within the aggregates mining sector. We will delve into specific applications that enhance operational efficiency, optimize resource utilization, and improve safety across the aggregates value chain, from quarry planning and extraction to processing and logistics. Presentations will highlight real-world case studies demonstrating the practical implementation and quantifiable benefits of these innovations, such as advanced geological modeling, autonomous equipment operation, real-time production monitoring, Blasting & fragmentation, and predictive maintenance. This topic is particularly relevant for aggregates engineers, data scientists, IT professionals, and operations managers who have successfully deployed and leveraged advanced software and technology to address industry-specific challenges and achieve significant operational improvements and sustainable growth.

3:25 pm

Guiding Decision Making With The Ethics of Risk

B. Simon-Lariviere; Unaffiliated, Elko, NV

Managing geotechnical hazards places high pressure on new geotechnical engineers who must consider safety, production, while still developing their technical decision-making abilities. These stressors can be challenging for new and experienced engineers alike, allowing phobic fear to create hesitation and uncertainty. This can lead to reinforcing indecision, eroding confidence, and stalling progression. The ethics of risk can provide a framework for managing varying levels of risk aversion (or inclination) while maintaining rationality over phobic fear, acting on manageable risk and preventing paralyzed decision making. This empowers new Geotechnical engineers to learn productive lessons, manage risk to personnel and production logically, and build confidence in their professional decisions.

3:45 pm

The Role of Mentorship in Retaining Female Talent in the Peruvian Mining Industry

F. Segobia Campos; Society for Mining, Metallurgy & Exploration, Cajamarca, Cajamarca, Peru

The Peruvian mining industry faces a critical challenge in retaining female talent due to persistent underrepresentation, cultural barriers, wage gaps, and hostile environments. This directly impacts productivity, innovation, and sustainability. Mentorship emerges as an essential, multifaceted tool. Programs facilitate knowledge transfer, develop soft skills, boost confidence and belonging, and mitigate challenging environments. This directly contributes to women's professional and personal development, enabling them to navigate industry complexities. By fostering organizational support, mentorship improves job satisfaction and reduces female staff turnover. While successful, large-scale implementation faces challenges like lack of commitment and resources. The future demands integrating technology (e.g., AI for matching, digital platforms) for scaling and customization. Mentorship must be part of a long-term diversity and inclusion strategy with explicit senior management support and intersectoral collaboration. This will transform organizational culture, ensuring female talent not only enters but thrives and remains in Peruvian mining.

4:05 pm

Lessons Learned from the Field: Practical Insights as a Drilling & Blasting Engineer

A. Morshedlou; Freeport McMoRan, Leadville, CO

Drilling and blasting play a critical role in achieving safe, efficient, and cost-effective production in surface mining. This presentation shares firsthand experience from working as a Drilling & Blasting engineer in a large-scale open-pit operation. Topics include blast design optimization, managing geology-driven challenges, and improving fragmentation for downstream efficiency. Practical examples will highlight how field data, crew collaboration, and continuous improvement can enhance safety, reduce costs, and meet production targets. The session aims to provide actionable insights for engineers, supervisors, and operators seeking to optimize blasting performance in day-to-day operations.

4:25 pm

Pursuing a Construction Support Engineering Role as a Young Professional

D. Buonanno; Mining Engineer - Young Leader Committee Member, Salt Lake City, UT

Throughout the life cycle of a mining construction project, multiple engineering firms, construction contractors, and owner's engineers collaborate to successfully design and support construction, often requiring various professionals to mobilize to the project site. In many cases, one of these roles involves representing the engineering firm as a construction support engineer to assist in the execution of designs. Taking on this position as a young professional can be a formidable challenge both professionally and personally, yet can deliver unmatched experiences that help shape one's career. This presentation will highlight the role of a rotational construction support engineer representing Hatch on a major process plant construction project in Arizona.

Monday, February 23
Afternoon

TAILINGS MANAGEMENT: TAILINGS PROFESSIONALS: ROCK STARS OF RESIDUE

Sponsored by Newmont

155B

Chairs: ***C. Hatton****, WSP, Parker, CO*
T. Braun*, SRK Consulting (U.S.), Inc., Denver, CO*
S. Li*, University of Utah, Salt Lake City, UT*

2:00 pm

Introduction

2:05 pm

Building Foundations: Early-Career Perspective in Tailings Engineering Through Practical Experience and Mentorship

E. Clement; SRK Consulting, Denver, CO

This presentation shares insights from our first two years as early-career tailings engineers, with a focus on how fieldwork and shadowing mentors shaped our professional development. Hands-on field assignments, including geotechnical drilling and construction quality assurance, provided valuable context beyond technical training. In-person office interactions with senior staff contributed to our growth by enabling informal learning and building strong team relationships. Through these experiences, we observed that early exposure to both fieldwork and workplace environments plays a critical role in preparing junior engineers. We invite discussion on approaches for prioritizing in-person experiences for the next generation of tailings professionals.

2:25 pm

The Forgotten Control: Organizational Structure as a Determinant of Tailings Risk Management Success

T. Welch; Harmony Gold, Dawesville, WA, Australia

While tailings governance has advanced through the Global Industry Standard on Tailings Management (GISTM), a critical risk control remains underexplored: organizational structure. This paper examines how structural design influences the effectiveness of tailings risk management. Drawing on real-world examples, it explores how reporting lines, technical independence, and clarity of accountability affect decision-making, governance quality, and risk exposure. Insights from organizational psychology are applied to align governance challenges with human factors such as role clarity and decision fatigue. The paper concludes with practical recommendations and a structural framework to help operators, regulators, and committees improve performance and accountability through fit-for-purpose organizational design.

2:45 pm

Tailings Stewardship, Artificial Intelligence and the New Landscape for Training Young Professionals in Engineering

J. Romero; WSP, Tucson, AZ

While artificial intelligence (AI) offers powerful enhancements for the engineering and operation of tailings management facilities, its limitations warrant critical scrutiny. The risks of over-reliance on AI-driven tools, including potential data biases, algorithmic opacity, the risk of eroding fundamental engineering judgment, and the challenge of maintaining accountability. Training young professionals presents a unique challenge: cultivating critical thinking and ethical discernment to ensure AI is employed as a supplement, not a substitute, for expertise. Emphasizing reflective practice and foundational knowledge, mentors must address the danger of blind trust in intelligent systems, preparing engineers to question, interpret, and responsibly integrate AI in sustainable resource management and ongoing professional development efforts.

3:05 pm

The Human Value for TSF Success and Safety

C. Winckler; Tailriskreview, St Augustine, FL

Tailings storage facilities (TSFs) are critical components of mining operations, requiring robust engineering, governance, and management to ensure their safety and sustainability. Whilst advancements in technology, protocols, and standards aim to create systems less reliant on individuals, the human factor remains pivotal to the success and safety of TSFs. This paper explores the multisystemic challenges such as deficiencies in leadership, instability in governance, budgetary constraints, and high staff turnover—that can lead to failures impacting not only business operations and shareholders but also local communities and the environment. This paper argues that whilst protocols, standards, and technological tools are invaluable in reducing reliance on individuals, their effectiveness is often undermined by organizational dynamics and human factors. By examining the interplay between these systemic challenges and technical approaches, this paper underscores the importance of prioritizing human expertise, leadership, and collaboration to ensure the safety and resilience of tailings storage facilities.

3:25 pm

Next Generation of Tailings Professionals: A Survey of Perspectives on the Talent Pipeline

M. Sadiq, K. Zadrozny and J. Harvey; Barr Engineering Co., Minneapolis, MN

Concerns have been expressed among senior professionals in various forums regarding the readiness and availability of the next generation of professionals to serve the tailings management industry. While organizations like TAILENG and the Tailings Center aim to address these gaps, one previous study suggested a disconnect remains between perceptions held by junior and senior professionals. This study proposes to survey junior professionals to better understand their successes and barriers to career growth, survey senior professionals to clarify their concerns, and examine academic programs to understand alignment with industry needs and the emerging talent pipeline. An in-depth evaluation of survey results, supplemented with commentary and anecdotes from both groups, will be discussed. These insights will highlight differences and commonalities in perceptions, expectations, and approaches to fostering career growth and strengthening the emerging talent pipeline within the tailings management industry.

3:45 pm

26-038

Mining the Future: Why Human Skills are the New Core Competence

S. Nowosad[1], T. Schmid[2] and M. Portal Valdivia[3]; [1]Curtin University, Kalgoorlie, WA, Australia; [2]LIFT, Kirchheim bei München, Germany and [3]Newmont, Cajamarca, Peru

Today's mining industry faces rapid transformation driven by automation, climate responsibility, and ESG demands, requiring more than technical expertise. Future mining engineers must blend engineering excellence with key human skills such as emotional intelligence, ethical decision making, leadership, communication, and self awareness. Based on two recent surveys to senior leaders and young mining professionals, this paper explores how these skills become core competencies vital for navigating complexity, leading responsibly, and enabling sustainable transformation. Furthermore, it also examines how educational institutions can adopt strategies to foster the development of these critical skills, preparing future mining talent for evolving challenges.

4:05 pm

Panel Discussion After Presentations (if time allows)

Monday, February 23
Afternoon

MPD: FLOTATION: PANEL SESSION - FLOTATION EQUIPMENT

Grand Blrm D

Chair: ***R. Kappes****, Newmont, Englewood, CO*

3:40 pm

Introductions

3:45 pm

Flotation Equipment Panel Session

R. Kappes; Newmont, Englewood, CO

The Mining Industry continues to face a number of technical challenges, which results in continued focus on controlling operating costs and improving production efficiency. Flotation as a mineral separation (pre-concentration) process has a critical role to play to optimize not only the mines and operations of today, but also those of the future. While improvements in flotation separations using chemistry and improving operational control have been mainly incremental – yet, extremely valuable, flotation equipment has seen a number of radical changes in design. Many equipment vendors offer a portfolio of products that either offer incremental improvements to existing equipment, or new flotation equipment. The focus of this panel is to learn a bit more from participants about where their focus is and have a honest debate on whether we should be focusing on incremental or step change improvements.

Tuesday, February 24
Morning

BULK MATERIAL HANDLING: CONVEYOR APPLICATIONS

155A

Chairs: ***S. Maldonado****, Freeport-McMoRan, Morenci, AZ*
M. Rubalcava*, Freeport-McMoRan, Morenci, AZ*

9:00 am

Introductions

9:05 am

Adapting the Flow: Mobile and Modular Bulk Material Handling Systems for Modern Mine Sites

T. Pinto; Astec, Chattanooga, TN

This presentation explores how mobile and modular bulk material handling systems can deliver real-world operational benefits on modern mine sites. With a focus on short-haul applications, it outlines how these flexible systems can reduce reliance on conventional yellow equipment, streamline haulage, and improve material flow efficiency. It also demonstrates how mobile equipment can work alongside traditional stockyard systems - such as stackers, bucket wheel reclaimers, or excavators -to reduce double handling, simplify logistics, and cut operating costs. The session presents practical examples showing how integrating mobile systems supports faster deployment, lower maintenance burdens, and greater adaptability in ever-changing production environments.

9:25 am

Report on First Rail-Running Conveyor (RRC) Operation at Sentinel Copper Mine, Zambia

M. Lurie[1] and C. Wheeler[2]; [1]FL Smidth Mining, Greenwood Village, CO and [2]University of Newcastle, Newcastle, NSW, Australia

First Quantum Minerals Limited (FQML) has constructed and commissioned the first of the company's Rail-Running Conveyor (RRC) systems at its Sentinel copper mine in Zambia, creating a flagship reference for this breakthrough innovation in bulk-haulage efficiency and safety. FQML executed the project in close partnership with OEM and the University of Newcastle, Australia. In RRC systems, small carriages running on rails carry a conventional belt, eliminating fixed idlers along the conveyor's main run. The technology offers OPEX savings ranging from 30-60% compared to conventional long overland conveyors, as well as substantial CAPEX reductions. At Sentinel, the RRC is a 3.25km retrofit to a 5ktph conveyor being re-located and extended to accommodate pit expansion. The RRC's ability to traverse much tighter curves allowed two transfer points to be eliminated. Based on the system's performance during its first few months of operation, this presentation covers key operational aspects including efficiency, carriage behavior, automated bearing monitoring, Live Digital Twin, and the hands-off carriage change-out system.

9:45 am

Case Study of a 809-Foot Vertical Sandwich Belt Conveyor Installation

I. Geresu; Dos Santos International, Marietta, GA

Sandwich Belt high angle conveyors have proven to be a versatile and efficient solution across a wide range of industries, including mining, quarrying, and material processing. This presentation features a case study of DSI's most recent and tallest installation, which vertically elevates 6-inch minus limestone 809 feet from the quarry floor to the surface at a rate of 600 tons per hour. The case study will highlight critical aspects of the project—system design, installation, and start-up—while demonstrating the advantages and practical benefits of Sandwich Belt high angle conveying in demanding applications such as elevating from underground mines.

10:05 am

Channar - 40 Years On

E. O'Donovan; O'Donovan Associates Pty Ltd, Mitchelton, QLD, Australia

When commissioned in the late 1980s, the Channar Project was a landmark in showing what could be achieved with Long Distance Conveying. Many of the project's remarkable achievements have rarely if ever been replicated. This paper looks at the reasons why this is the case and why we should revisit this project for guidence into the future.

10:25 am

Evolution of the Pipe Conveyor

B. Torchio; Continental, São paulo, São Paulo, Brazil

The pipe conveyor concept originated over 60 years ago and has since evolved into a highly refined solution for a wide range of material transport challenges. Today, ContiTech is at the forefront of this evolution, transforming pipe conveyors from a one size fits all approach into a custom engineered science. This presentation offers a behind-the-scenes look at the capabilities, limitations, and complexities of these systems. We'll explore how ContiTech applies advanced engineering tools, from finite element analysis to physical testing, to optimize performance, reliability, and longevity in demanding applications. Attendees will gain insight into how pipe conveyors are designed, validated, and refined for real-world success.

10:45 am

Caval Ridge Overland Conveyor

T. O'Donovan; SME, Ferny Grove, QLD, Australia

The Caval Ridge Overland Conveyor is a 10.4km, 2800tph system running at 7.3m/s in Central Queensland, Australia. It was commissioned in 2018 as a highly successful, low resistance system capable of carrying well over design capacity. However issues with the design and project planning of the system led to lengthy delays during installation. The purpose of this paper is to highlight both the effective design aspects of the system, as well as the lessons learned from perspectives of project planning, inter-team communication, and design focus throughout the project.

Tuesday, February 24
Morning

COAL & ENERGY: COAL MINE ROCK MECHANICS

151G

Chair: ***M. Johnston****, USGS*

9:00 am

Introductions

9:05 am

Unmapped Plastic Clay Layer as a Key Factor in Highwall Instability: A Coal Mine Case Study

A. Zingano; UFRGS, Porto Alegre, RS, Brazil

This study is a geotechnical investigation of slope instability on an active coal mine in southern Brazil. Cracking and localized slippage were observed following exposure and unloading of a thin, highly plastic white clay seam located at the base of a siltstone horizon. Intense rainfall triggered accelerated shear displacement along the weak clay layer. A back-analysis was conducted using limit equilibrium and numerical modeling (Slide2), supporting the design of stabilization measures such as a gravity wall and slope regrading to a 1:3 (V:H) configuration. Slope monitoring and laboratory testing were implemented to ensure long-term geotechnical performance and support mining closure planning. The resulting factor of safety was deemed acceptable for the safe resumption of mining operations.

9:25 am

Incorporating Seam Geometry and Spatial Orientation into Surface Deformation Prediction Above Longwall Mining

B. Diddle, C. Hernandez-Garcia and Z. Agioutantis; University of Kentucky, Wilmore, KY

This work presents a methodology for predicting subsidence over three-dimensional dipping coal seams. The influence function as incorporated in the Surface Deformation Prediction System (SDPS) is used to consider the shape of the seam. Several new features of the program are displayed. The sensitivity of several surface deformation indices to the seam geometry is evaluated. This work attempts to expand upon the best practices for analytical prediction of subsidence above coal mines.

9:45 am

Development of Site-Specific Subsidence Model Parameters for Past Longwall Mining Operations

C. Hernandez-Garcia, B. Diddle and Z. Agioutantis; University of Kentucky, Lexington, KY

The Surface Deformation Prediction System (SDPS) software package has been used by government agencies and operators for several decades to predict surface deformations above full extraction coal operations. These predictions are based on the influence function method and use site-specific or regional parameters. SDPS version 7 is a completely rewritten version of the software package that allows for both calculations over extracted panels and enhanced calibration methodology for the development of site-specific subsidence parameters. This study aims to develop site-specific subsidence model parameters both for static (or final) subsidence calculations as well as dynamic subsidence calculations. The analysis is performed utilizing historical data from the Quarto 7 mine, where one panel was surveyed for over 12 months using three monument lines—one longitudinal and two transverse. Comparisons between measured and predicted subsidence in both dynamic and final stages confirm the applicability of the influence function method and yield site-specific subsidence parameters both for final and dynamic calculations.

10:05 am

Subsidence Risk Analysis of Property Overlying a Historic Coal Mine Using Probabilistic and Numerical Models

E. Maldonado Esguerra, S. Fay and R. Ray; RESPEC, Lexington, KY

Historical room-and-pillar coal mining partially underlies a property planned for construction. Although mining ceased a century ago and no active underground operations exist nearby, a risk of mining-related ground deformation remains. A predictive subsidence numerical model was developed under various pillar collapse scenarios using core drilling information, mine maps, and historical records. This data was used to complete stress-strength models and calculate safety factors. These factors were then used to assess subsidence risk due to potential pillar and roof failure. Considering safety factor thresholds, Monte Carlo simulations were performed to quantify the probability of failure. Based on the influence of pillar and roof stability, results from the models showed low subsidence deflection values and low probability percentages for ground deformation at the property. The maximum predicted subsidence deflection for a one-pillar failure across the three model types examined was 0.40 inches, with a probability of 4.6%. While deflection increases with additional pillar failures, the probability of such failures decreases.

10:25 am

The Role of Floor Failure in Delayed Subsidence in Development Only Room-and-Pillar Mines

D. Newman; Appalachian Mining & Engineering, Inc., Lexington, KY

Delayed subsidence can occur years or decades after room-and-pillar coal or limestone mining is completed. It typically results from progressive floor failure caused by mine inundation and the subsequent loss of bearing capacity. Floor heave initiates a slow cycle of pillar deterioration, as tensile cracks develop in the ribs, reducing the effective pillar area, increasing pillar stress, and promote additional deformation. As spans between pillars widen, roof failure follows. This paper presents case histories of delayed subsidence in Illinois, Kentucky, and Pennsylvania, and describes remediation techniques used to protect surface structures where mitigation is required.

10:45 am

26-027

Using Machine Learning to Interpret Dynamic Coal Failures

D. Warren[1], A. Alex[1], S. Wright[1], H. Lawson[2] and T. Meuzelaar[1]; [1]Life Cycle Geo, LLC, Dacula, GA and [2]Indiana University, Bloomington, IN

Dynamic coal failure events remain an imperative safety concern in underground coal mining. Previous studies reveal a strong empirical correlations between a history of reportable dynamic failure events in the United States and compositional attributes of the mined seam. This raises questions regarding whether compositional attributes act as proxies for known stratigraphic risk factors, are indicative of fracture characteristics of the coal itself, or some combination of these. To answer these questions, laboratory experiments in which dynamic failure was induced in coal samples of varying composition were performed. This study augments previous findings and considers additional variables, combined with compositional data analysis and machine learning techniques, to isolate and understand coal's inherent bursting capacity. Results confirm some relationships between coal chemistry and failure classification and also imply that stratigraphic risk factors such as competent roof units may be a dominant risk factor in dynamic failure events occurring in the United States.

Tuesday, February 24
Morning

COAL & ENERGY: COAL PREP OPERATIONS & PROJECTS

151 D-F

Chairs: ***E. Wolfe****, Robindale Energy, Latrobe, PA*
J. Nielson*, Core Resources, Tucson, AZ*

9:00 am

Introductions

9:05 am

Enhancing Magnetite Recovery in Coal Preparation Plants Using a Hybrid Element Wet Drum Magnetic Separator

K. Schaff[2], J. Marin[1] and X. Jiang[1]; [1]Eriez Manufacturing Co., Fairview, PA and [2]Signal Peak Energy, Roundup, MT

Magnetite loss in heavy medium circuits at coal preparation plants accounts for a significant portion of operating costs. Enhancing magnetite recovery has therefore been a long-standing objective for improving plant efficiency and reducing operation cost. A new generation of wet drum magnetic separators featuring a hybrid magnetic circuit—combining ceramic and high-energy rare earth magnets—has been successfully applied in both iron ore and coal heavy medium systems. The hybrid element design delivers approximately 60% higher magnetic field intensity in the separation zone compared to the industry-standard 950-Gauss interpole circuit. When paired with a self-leveling tank, this design has achieved an improvement of about 10% in magnetite recovery in iron ore processing plant. At Signal Peak Energy, a hybrid element wet drum separator was installed alongside a conventional 950-Gauss unit, enabling a direct performance comparison. This paper presents metallurgical data from both units, highlighting the superior performance of the hybrid element design—with peak magnetic field strengths of 950/3500 Gauss—in improving magnetite recovery in coal preparation operations.

9:25 am

Blue Creek Preparation Plant - Latest US Metallurgical Coal Plant

P. Saunders; Warrior Met Coal, Vestavia, AL

The Blue Creek Coal Preparation Plant began operation during Q2 of 2025, when the first of three (3) modules came on-line. This plant has many unique attributes that separate it from many others in the industry; these will help to ensure maximum coal recovery, as well as helping Warrior to meet various goals, such as a 25% water use reduction by 2030, and utilizing alternate slurry processing / disposal methods. This Preparation Plant is made up of three (3) identical modules, all can run simultaneously for a total capacity of 1800 TPH. Each module can independently be taken offline to allow for maintenance. The Blue Creek Plant utilizes well-known separation equipment such as heavy media cyclones, spirals, and stack cells, but also incorporates next-generation screen bowls, which are capable of higher RPMs as well as variable scroll differential speeds. Solid bowls are utilized to capture ultra fine coal from the screen bowl effluent to maximize coal recovery. The plant also utilizes solid bowls to separate water and fine / ultrafine refuse, so that the solids can be disposed of along with the course refuse generated from the preparation plant.

9:45 am

Another Case Study for Jet Type Flotation Cells Application at a Met Coal Preparation Plant Upgrade

Z. Wang and Z. Li; The Daniels Company, Bluefield, WV

In 2020, a major metallurgical coal producer in the Appalachian region partnered with the Daniels Company to boost the throughput capacity of the flotation circuit at their coal preparation plant in western Virginia. This was achieved by installing new Jet-type flotation cells alongside the existing ones. Over time, the original flotation cells required extensive maintenance, and the supporting steel structure had significantly deteriorated. By 2024, the producer engaged Daniels to replace the aging cells with additional Jet Cells. Following the commissioning of the new Jet Cells, their performance was evaluated against historical data from the previous system. The results showed an additional flotation concentrate of 14 tph on average over an eight-month operational period. This enhancement is primarily attributed to the Jet Cells' ability to generate fine micro-bubbles, enabled by circulating pumps and mixing nozzle assemblies. A comparison of operating costs between the two flotation technologies revealed annual savings of approximately $14,000. The upgrade has proven to be a strong success for the producer in terms of return on investment as well as safety improvement.

10:05 am

Proper Design of Material Transfer Points in Coal Handling Systems

J. Nowoselski; Jenike & Johanson, Mississauga, ON, Canada

Properly designed material handling systems are very important for the efficient processing of any bulk material. Coal, particularly when it is fine and wet, can be a very challenging to handle. This sticky material often leads to buildup and pluggages in the transfer chutes within its processing system, causing significant and costly downtime. The proper design of these coal transfer chutes can eliminate potentially crippling flow problems for this seemingly impossible-to-handle material. Understanding the flow properties of your material, and then applying them to the design of your transfer chutes using tools like discrete element method (DEM) to perform flow simulations, ensures that any potential problems can be identified and eliminated before the equipment is built.

10:25 am

Two-Liquid Flotation (TLF) of Thickener Underflows to Obtain Low-Ash and Low-Moisture Coals

J. Leland, M. Gupta, A. Srinivasan, K. Huang, A. Noble and R. Yoon; Virginia Tech, Blacksburg, VA

In general, oil droplets can form nearly twice as large contact angles (q) as air bubbles on a hydrophobic surface, which prompted many investigators to use oil droplets rather than air bubbles to recover fine particles. The process, known as two-liquid flotation (TLF), has been tested using a recyclable oil (iso-hexane) as the oil phase. The process has been tested on several thickener underflow samples to produce low-ash products at high recoveries. The clean coal products were practically dry by virtue of the dewatering-by-displacement mechanism (US 5,458,786). The spent oil was nearly completely recovered by using steam or heated nitrogen.

10:45 am

Enhanced Centrifuge Dewatering Using Low Molecular Weight Flocculants: A Shift in Polymer Design for Coal Refuse Tailings

S. Wagner; SNF, Sherwood Park, AB, Canada

High molecular weight flocculants (HMWF) are commonly used in mining tailings centrifugation but often result in high cake moisture, poor mixing, and reduced throughput. This study introduces low molecular weight flocculants (LMWF) designed to enhance separation efficiency. Contrary to expectations, LMWF consistently outperformed HMWF by improving dispersion, mixing, and interaction with solids, forming smaller yet more effective flocs. Under optimized conditions, LMWF achieved a 5% increase in cake dryness, 7% reduction in centrate solids, and 17% decrease in polymer consumption. These results highlight LMWF as a more efficient, sustainable alternative for tailings dewatering in solid bowl centrifuge applications.

11:05 am

26-013

Chemical Enhancement of Sub-20 Micron Particle Recovery – 4 Case Studies

M. Barish, J. Fisher, L. Kolbush, T. Toney and A. Vaughn; Somerset International, Sewickley, PA

Somerset International has worked to enhance the recovery of sub-20 micron particles in our patented Sub325 Systems by introducing chemicals in the systems prior to the centrifuge. This paper details four cases of such enhancement. Two on the fine coal recovery side at a 400 TPH plant and 1400 TPH plant. Two on the tailings dewatering side at a 250 TPH plant and a 1200 TPH plant.

11:25 am

Improved Dewatering Using Ultrasound – Case Study

S. Ahmadzai[1], T. Rauhala[1], N. McAlonen[1], T. Toney[2] and A. Vaughn[2]; [1]Altum Technologies, Calgary, AB, Canada and [2]Somerset International, Sewickley, PA

In dewatering applications installations high G-force centrifuges can be used to deliver efficient and complete solid-liquid separation and water recovery. Introducing an ultrasound field into the inlet flow can disrupt the extracellular polymeric substances (EPS) that bind water to sediment reducing the moisture content. Detailed in the paper will be actual results from an Altum Technologies installation using software controlled, externally mounted transducers in the Somerset Systems at the Warrior Met Coal Blue Creek Plant. Applications in coal recovery as well as tailings dewatering will show the improvements in moisture content and water recovery.

Tuesday, February 24
Morning

COAL & ENERGY: TECHNOLOGY, INNOVATIONS, & AI/ML

Sponsored by BARR

151 A-C

Chairs: ***E. Shereda****, Core Natural Resources, Canonsburg, PA*
M. Keener*, Mine Engineer, Sycamore, PA*

9:00 am

Introductions

9:05 am

Integrating Artificial Intelligence into Mining Engineering Education: Curriculum Design and Early Outcomes

R. Alhaj Bedar, S. Schafrik, A. Moradi, Z. Agioutantis and P. Roghanchi; University of Kentucky, Lexington, KY

Artificial Intelligence (AI) and Machine Learning (ML) are transforming every facet of modern mining operations, from exploration and planning to safety and automation. Recognizing the growing demand for AI/ML proficiency in the mining industry, a comprehensive survey of professionals, government representatives, academics, and students revealed a significant gap in current mining engineering curricula. In response, the authors have developed and implemented a dedicated course focused on the application of AI and ML in mining contexts. This paper outlines the structure, content, and learning objectives of the inaugural offering of the course. It also highlights the assignments used to reinforce core concepts and discusses preliminary outcomes from the first cohort of students.

9:25 am

Predicting Miner Localization in Underground Mine Emergencies Using a Hybrid CNN-LSTM Model with Data from Delay-Tolerant Network Databases

P. Nonguin, S. Frimpong and M. Raza; Missouri University of Science and Technology, Rolla, MO

The mining industry, especially underground mining, supplies critical minerals but exposes workers to hazards such as cave-ins, fires, and gas explosions. Real-time miner localization during such emergencies is vital for rescue and self-escape. While the MINER Act of 2006 mandates tracking systems, existing solutions often fail in GPS-denied, dynamic underground environments. This study presents an AI-based approach using Delay-Tolerant Networking (DTN) data to predict miner locations. A deep learning model combining Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) networks was trained on a simulated dataset of over one million entries from 26 pillar classes. The model achieved 89% accuracy, 89% recall, and 83% F1-score. Simulations based on Missouri S&T's Experimental Mine confirm the model's strong predictive performance. This work highlights the potential of AI and DTN integration to enhance emergency response, support compliance with safety regulations, and improve miner survival outcomes.

9:45 am

Language Model Based Incident Prevention Technology Development

E. Cobbinah and R. Ganguli; University of Utah, Salt Lake City, UT

Mining incident reports contain detailed narratives that traditional safety analysis rarely leverages to full potential. To add to traditional tools, large language models (LLMs) were used to systematically extract insights from historical incident narratives. A LLM was fine tuned to summarize incident reports from coal mining and identify underlying root causes. A comprehensive corpus of MSHA fatality and accident reports was used to train the model. To ensure outputs are accurate and context-rich, the fine-tuned model was deployed within a retrieval-augmented generation pipeline. The resulting summaries and analyses were qualitatively evaluated against expert interpretations to verify their fidelity and practical relevance. Outcomes included the development of a safety analysis tool that enabled domain-experts to query in plain language and receive context-rich incident summaries and root cause explanations of mining incidents. By making years of unstructured narrative data more accessible and interpretable, this approach supports more informed preventive strategies and improvements to safety procedures.

10:05 am

Underground Network Design – Key Driver in Technological Advancement

J. Lewis and B. Wall; Leer Mine Complex, Grafton, WV

The Leer Mining Complex has an extensive fiber optic network extending to strategic locations underground and on the surface. The need to expand system capabilities became apparent as the footprint of the operation increased. The new functionality led to the inclusion of VOIP phone systems, wireless access points, surveillance systems, enhancing the capabilities of existing mine safety systems and aided in the development of software that allows MSHA mandated exams to be recorded electronically. The network plays a significant role in the success that the Leer Mine has had in implementing shearer automation, controlling and monitoring critical infrastructure in real time while providing key insights into mine conditions.

10:25 am

From Theory to Stockpile: Enhancing Optimisation Models with Stockpiling Constraints

T. Vink and L. Okada; Deswik, Brisbane, QLD, Australia

The multi-commodity network flow problem is regularly solved using a linear programming (LP) formulation. The addition of intermediate storage arcs to the model allows for the representation of real-world stockpiles that can store material across time and greatly increases the applicability of the model to mining and logistics scheduling. However, these stockpiles can often have complex operational constraints such as the requirement for a last-in, first-out (LIFO) stack or first-in, last-out (FIFO) queue. This paper presents a linear programming solution to include LIFO and FIFO stockpiling in the LP, further extending upon the practical application of the model. It further examines how this approach has been applied to coal operations around the world.

10:45 am

High-Value Applications for Directional Drilling with Geosensing in Coal Mines

D. Brunner and B. Lyddall; REI Drilling, Inc., Salt Lake City, UT

Directional drilling has long supported coal mining operations for methane drainage, geologic exploration, abandoned mine verification, water transfer, de-stressing, and utility installation. Recent advancements–particularly the integration of the Yabby Geosenseing System-have transformed these practices. Delivering real-time drilling performance, positional, geophysical, geomechanical, and reservoir characteristics to the drill operator and engineering and geology professionals, enables dynamic interpretation-based adjustments to drill plans and enhances subsurface characterization. This presentation outlines engineering-focused applications where geosensing yields the greatest value: pre-slope development drilling to assess lithology, rock quality, hardness, fractures, and define inflows, deriving the displacement across compounding normal faults and quantifying their roles in gas and fluid migration, and defining and draining areas of high residual gas content where coalbed methane wells were implemented in advance of mining. These examples demonstrate how geosensing informs engineering decisions and optimizes drilling outcomes in complex geologic settings and reservoirs.

11:05 am

Impact of Deploying Time Series Platform and Gamification of Performance

S. Dessureault[1] and E. Shereda[2]; [1]Dr Data Mining, Tampa, FL and [2]Core Natural Resources, Canonsburg, PA

This case study highlights the impact of deploying a performance gamification platform powered by a data warehouse and time-series platform. It demonstrates how displaying leading indicators, such as process stability or shift start-up tons, in a gamified manner, to operators and supervisors leads, to measurable performance improvements. Targeted initiatives, such as tracking magnetite consumption with time-series visualizations and evaluating process stability by operator, combined with coaching through scorecards, reduced magnetite consumption per ton of coal cleaned. The underlying motivation is to showcase how gamification, when driven by detailed plant data collected via modern time-series platforms, can meaningfully enhance performance.

11:25 am

From Vision to Reality: Advancing Underground Room-and-Pillar Automation

B. Jones[1] and T. Hayford[2]; [1]Matrix Design Group, Lexington, KY and [2]Matrix Design Group, Newburgh, IN

Underground automation in room-and-pillar mining presents both complex challenges and transformative opportunities. This session will outline Matrix's phased approach to enabling automation in high-risk, GPS-denied environments. From onboard sensing and collision avoidance to remote operation and machine-to-machine coordination, we'll explore the foundational technologies required, including AI, edge computing, communications infrastructure, and electrification. Emphasis will be placed on the real-world validation of these solutions through partnerships with mining operators, OEMs, and technology providers. Attendees will gain insight into how Matrix is integrating proven components and strategic collaboration to make safe, scalable underground automation a near-term reality.

Tuesday, February 24
Morning

ENVIRONMENTAL: MINE CLOSURE & RECLAMATION

Sponsored by ARCADIS

255A

Chairs: ***L. Vecchiarelli****, Arcadis US Inc, Syracuse, NY*
S. Bogart*, Consultant, Syracuse, NY*

9:00 am

Introductions

9:05 am

Reclaiming Coal Refuse in the Canyons of Carbon County

D. Kolstad; Barr Engineering Co, Minneapolis, MN

Coal mining in Carbon County, Utah, dates to the late 1800s, leaving coal refuse likely associated with the historic Lolly and Carbon Fuels mines in Hardscrabble Canyon. Reclaimed and stable for decades, refuse was exposed after a 2021 wildfire increased runoff potential, and extreme storms eroded creek banks. The volume of refuse, steep slopes, and active roads created unique engineering challenges. The updated reclamation design expands channel capacity, stabilizes banks, integrates cascading water features, and consolidates refuse into onsite borrow areas. Excess high-quality refuse will support local power generation. Public access will be preserved for this popular hiking and viewing area.

9:25 am

When Mine Closure Lacks Dollars and Sense: Common Pitfalls and Practical Solutions in Mine Closure Planning

A. Hood; ERM, Mesa, AZ

Mine closure poses complex, often underestimated, multi-dimensional challenges that generate substantial financial, operational, and environmental liabilities. These challenges intensify in remote settings, where logistical and ecological constraints amplify cost overruns and planning oversights. This paper examines recurring pitfalls in closure planning: unverified assumptions, missed cost efficiencies and interim solutions, inadequate baseline data, and impractical designs. Drawing on North American case studies, we show how overlooking operational details can produce avoidable complications. We propose a backward-planning approach: define the end state first, then align resources, practices, and realistic environmental criteria to verify assumptions early, enhance cross-departmental communication, and keep designs achievable without costly external interventions. This adaptive, iterative process refocuses closure from a checklist to a practical strategy that aligns with regulatory requirements. It also emphasizes proactive stakeholder engagement and regulatory alignment to secure socially accepted and compliant closure outcomes.

9:45 am

How Risk Assessment Avoided Unnecessary Reclamation

A. Thatcher and A. Anthony; Arcadis U.S., Inc., Broomfield, CO

In southeast Idaho, Bureau of Land Management approved a number of closures in the 1990s based on approved borrow source. The reclamation was later determined to contain elevated selenium in various media. There were CERCLA-based consent orders for several of the mine sites located on U.S. Forest Service property. For these sites, the CERCLA process was reviewed and a strategy rooted in human health and ecological risk assessment (ERA) was derived to understand the actual risk of the selenium. A key aspect of the strategy included understanding the conceptual site model and, particularly, habitat as a driver for what species would occur on certain parts of the site. The ERA focused on multiple lines of evidence to formulate conclusions. Aquatic, avian and small mammal communities were observed and sampled. Toxicological criteria for birds and small mammals were re-evaluated, and new toxicity reference values were developed based on empirical data collected on communities in the region. Several sites had ERAs with no unacceptable risk to receptor populations based on habitat and community metrics in addition to hazard quotients following standard risk assessment policy.

10:05 am

26-028

Effect of Soil Amendments on Short-Term CO2 Fluxes on Revegetated Mine Soil

W. Zoogah, M. Al-Lami, D. Abdullah, K. Awuah-Offei and D. Burken; Missouri University of Science and Technology, Rolla, MO

Reclaiming degraded mine lands presents a significant challenge due to poor soil conditions. While soil amendments are known to improve soil conditions such as soil carbon content, there is still some uncertainty on the impact of different soil amendments on soil carbon and Carbon dioxide (CO2) fluxes. This research evaluates the variation in CO2 flux resulting from different soil amendments (biochar, manure, woodchips, and arbuscular mycorrhizal fungi) applied to mine soil. We conducted high-frequency CO2 measurements and soil sampling on 15 pilot plots at a revegetated mine site over a three-month period (July-October 2025). ANOVA-based statistical analysis that compared the effects of amendments on short-term CO2 fluxes between treated and untreated plots showed variation in CO2 emissions among different treatments. This study provides initial insights into the effect of amendments on CO2 fluxes, offering preliminary insights on the effect of soil amendments on carbon cycling and recommendations for sustainable mine reclamation practices.

10:25 am

The Art of Reclamation: Insights from Mine Reclamation Construction

D. Osterhout; Burns & McDonnell, Downers Grove, IL

Mine reclamation is vital for the sustained success of mining operations and the long-term well-being of surrounding communities. However, challenging terrain, harsh weather, limited material access, extensive wetlands and wildlife habitats, and remote locations often complicate effective reclamation planning and execution. This presentation draws on seventeen years of heavy civil mine reclamation experience across North America, highlighting best practices and key lessons learned from both successful and difficult projects. It will explore strategies for collaborating with engineers to develop practical, constructible solutions tailored to complex site conditions. Additionally, it will address the importance of innovative techniques, thoughtful material selection, and meaningful community engagement. Covering all phases—from design and planning through execution and turnover—this presentation aims to serve as a practical guide for achieving successful, resilient mine reclamation.

10:45 am

Differential Mine Closure Model for ASGM in Colombia: Adapting German Strategies

T. Vallejo Lopez and O. Restrepo Baena; Universidad Nacional de Colombia, Medellín, Antioquia, Colombia

This study assesses the potential to adapt Germany's mine closure strategies to the Colombian context, focusing on Artisanal and Small-Scale Mining (ASGM). Using a socio-technical methodology and two case studies—surface and underground mines—structural barriers in governance, regulation, and financing were identified. A differential model is proposed with three pillars: creation of District Closure Funds, promotion of miner-community associations, and a technical portfolio including geotourism, ecological restoration, and water reservoirs. The model aims to transform environmental liabilities into territorial opportunities through a cost-effective, participatory, and sustainable approach tailored to the realities of the Colombian ASGM sector.

Tuesday, February 24
Morning

ENVIRONMENTAL: MINE WASTEWATER TREATMENT

255D

Chairs: ***J. Schmidt****, Jacobs, Tempe, AZ*
T. Graham*, Freeport McMoRan, Mesa, AZ*

9:00 am

Introductions

9:05 am

Meeting Mine Water Sulfate and Chloride Discharge Limits with Creative Coagulation Chemistry

M. Owens, S. Rastogi, D. Donkin and P. Jarrett; UCC Environmental, Midlothian, VA

This paper will present results from a recent bench scale treatability study performed on wastewater from an iron mine in the north central United States. The mine is facing competing wastewater discharge requirements for sulfates and chlorides as well as Total Dissolved Solids (TDS). The use of traditional mineral coagulants generally adds TDS (ferric chloride, ferric sulfate, etc.) making it important to select a coagulant that is effective without exacerbating issues with TDS in the discharge. This paper will present the results of the study where a number of coagulant chemistry approaches were tested to balance compliance with these limits. Tested approaches include both traditional mineral coagulants as well as specialty chemicals. Results will be presented for each coagulant dosage along with corresponding effluent data for iron, sulfates, chlorides, TDS, and selenium.

9:25 am

Treating Antimony to Meet NDEP Profile I: How an Innovative Antimony Treatment Process Increased Water Treatment Plant Recovery by 50% and Saved $3M in Brine Management Controls

D. Eames; WaterTectonics, Everett, WA

A Nevada gold mine needed to improve their wastewater treatment plant (WTP) due to low RO water recovery (65%) and brine storage ponds near capacity. The key water contaminants of concern were arsenic, antimony and sulfate. The project team developed, non-membrane approach to precipitate antimony to improve water recovery. These process changes alone improved water recovery to 87%. Process controls were critical to the success of the water treatment system. The water quality parameters will be presented describing the first eight days of operations through the process train. A step-by-step discussion of the process drivers, performance impacts, design modifications and results will be presented. Through improved site operations and water balance, the team was able to remove the RO from the process and the plant recovery increased to 99%. Lessons learned throughout three years of operations will be presented. Operational and process changes made during this period improved recovery from 65% to 87%, and ultimately to over 99%. The mine was able to cancel construction of additional brine ponds, saving more than $3 million dollars.

9:45 am

Pilot Program for PFAS Removal in Public Water Systems on Mine Sites

S. McLeod and F. Jordan; WestLand Resources, Tucson, AZ

Many mining properties own and operate aging public water systems. Despite their age, these systems still need to be maintained in accordance with EPA and local jurisdictional requirements. Mines with aging systems should start planning for the potential of having to treat their drinking water for PFAS. WestLand is currently working with a mine that is taking a proactive approach; first they monitored for PFAS and now they are conducting a pilot study targeting the specific PFAS constituents found in their source water. In this presentation, we discuss the need for PFAS monitoring, testing, removal, and the pilot study results.

10:05 am

Breaking the Gypsum Barrier: Advancing High-Recovery Reverse Osmosis for Mining & FGD Waters Using Flow Reversal Technology

M. Finder; ROTEC, Freehold, NJ

Calcium sulfate (gypsum) scaling is a key limitation to high-recovery RO in mining water treatment, particularly for mine dewatering. Conventional RO systems must limit gypsum saturation, capping recovery and requiring high antiscalant doses or chemical softening. Flow Reversal Reverse Osmosis (FR-RO) periodically reverses concentrate flow through each RO block, disrupting crystal growth and minimizing residence time of supersaturated brine. This dynamic operation suppresses scaling even at high saturation. Field results from a brackish groundwater RO in Israel show stable operation at >400% gypsum saturation, with a 50% antiscalant reduction and recovery increase from 76% to 84%. Preliminary designs for FGD streams show similar potential. Research from the University of California confirms FR-RO disrupts gypsum nucleation. This presentation will share field data, FGD design concepts, and literature insights into the mechanism. FR-RO offers a practical path to higher recovery and lower OPEX in gypsum-limited mining and industrial applications.

10:25 am

Remediation of Uranium Contaminated Waters Using Green Glycolipid-Based Technologies

D. Hogan[1], S. Perez[1], V. Lokugama[1], D. Loy[1], C. Boxley[2] and R. Maier[1]; [1]University of Arizona, Tucson, AZ and [2]Glycosurf, Inc., Salt Lake City, UT

Uranium mining in the United States has impacted waters across the arid southwest, endangering human and environmental health. Due to limited water resources and expanding demand, it is increasingly important to develop sustainable, cost-effective technologies capable of removing uranium from mining-influenced waters. Bioinspired glycolipid surfactants are promising candidates for such an application, as they are non-toxic, biodegradable, and selective for uranium and other critical metals, such as the rare earth elements. This presentation highlights several glycolipid-based technologies for the remediation of mining-impacted waters. Through methods such as ion flotation and resin adsorption, we will show the recovery of uranium from mining-influenced waters and demonstrate the potential of these technologies to valorize metals and produce clean water for both economic and environmental benefit.

10:45 am

Innovations in Approach to Passive Treatment of a Remote, High-Elevation, Cold-Climate Acid Rock Drainage (ARD) from a Highway Road Cut

R. Thomas, A. Timmis, A. Campbell and E. Reeves; Jacobs, Atlanta, GA

Two passive treatment systems have been implemented to treat ARD generated from a highway road cut at high elevation in British Columbia. The first passive water treatment system features an innovative pre-treatment unit, the acidity neutralization cell, to remove hydrolysable metals and raise the pH before downstream treatment with more traditional biochemical reactors. The second passive treatment system is designed to treat groundwater adjacent to the receiving stream. The second treatment system is set at or below the local water table with a limestone drain layer running under the length of the system. The stream is lined to help isolate and force groundwater into this treatment system. The system consists of a series of three lined vertical bioreactors for acidity neutralization and metal removal followed by three unlined surface flow wetlands. Groundwater in the underlying limestone bed mixes in the surface flow wetland with treated water from the upstream bioreactor. Both systems have been successfully operating for multiple years. Design challenges, remote and cold-climate operations, and treatment success will be covered in this presentation.

Tuesday, February 24
Morning

HEALTH & SAFETY: CMSP INFORMATIONAL SESSION

Sponsored by RioTinto

250A

Chairs: ***D. Curry****, Allegheny Metallurgical*
J. Loff-Peterson*, Member, Mondovi, WI*

9:00 am

Introductions

9:05 am

CMSP Informational Panel

J. Loff-Peterson; Barr Engineering Co, Minneapolis, MN

As mining operations grow more complex and safety expectations rise, the role of the Certified Mine Safety Professional (CMSP) has become increasingly vital. This panel will explore how CMSP-certified professionals are shaping the future of mine safety through leadership, technical expertise, and a commitment to continuous improvement. Key Discussion Areas: - Professional Standards & Certification Impact - How the CMSP credential enhances credibility, consistency, and accountability in safety practices across mining operations. - Leadership & Safety Culture - The influence of CMSP-certified professionals in building proactive safety cultures and driving behavioral change. - Regulatory Navigation - Leveraging CMSP training to interpret and comply with MSHA regulations, prepare for inspections, and manage risk effectively. - Career Development & Workforce Engagement - Promoting CMSP certification as a pathway for professional growth and a tool for mentoring the next generation of safety leaders. Panelists will include CMSP holders, safety directors, and industry advocates who will share real-world insights and strategies for advancing safety performance through certified expertise.

Tuesday, February 24
Morning

HEALTH & SAFETY: TOTAL WORKER HEALTH: BUILDING SUPPORTIVE WORKPLACES

Sponsored by RioTinto

250B

Chairs: ***L. Guasta****, Environmental Resources Management, Parker, CO*
K. Walster*, Prairie State Generating Company, Marissa, IL*

9:00 am

Introductions

9:05 am

Enhancing Workplace Safety and Mental Health Through 5S Implementation in a Mining Warehouse

M. Aghdamigargari[1] and J. Carmona[2]; [1]School of Mining Engineering and Mineral Resources, University of Arizona, TUCSON, AZ and [2]ASARCO LLC, TUCSON, AZ

This study explores the implementation of the 5S methodology (Sort, Set in Order, Shine, Standardize, Sustain) in a mining warehouse to improve operational efficiency and employee mental well-being. By involving staff in each phase of 5S, the initiative led to a safer and more organized work environment. Survey results showed that 82% of employees noticed improvements in cleanliness and predictability, and 73% reported greater job satisfaction, a stronger sense of ownership, and increased hazard awareness. The findings suggest that 5S is a practical strategy not only for enhancing material management but also for fostering a more supportive workplace in mining.

9:25 am

"There's No Whining in Mining": Reframing Mental Health and Psychological Safety in High-Hazard Work Environments

L. Guasta; Environmental Resources Management, Denver, CO

In the mining industry, where toughness and resilience are deeply ingrained cultural values, discussions around mental health are often met with resistance or minimized with phrases like "There's no whining in mining." While intended to promote grit, this mindset can unintentionally silence real struggles, reinforce stigma, and erode psychological safety—an essential foundation for both individual well-being and team performance. This presentation challenges outdated narratives and explores the critical intersection of mental health, psychological safety, and high-hazard work. Drawing from contemporary research and real-world case studies, it will highlight how psychological safety enables early intervention, supports peer accountability, and ultimately improves safety outcomes. Attendees will learn actionable strategies to foster environments where workers feel safe to speak up—not only about physical hazards but also about stress, fatigue, and mental health concerns—without fear of judgment or retaliation. It's time to move from stigma to support, and from silence to strength, in building healthier, safer mining workplaces.

9:45 am

Managing the Change: Building Safer, Smarter and Supportive Mining Workplaces Through Human – Machine Collaboration

R. Osei, S. Frimpong and A. Venkat; Member, Rolla, MO

Human–machine collaboration in Mining Industry 4.0 offers new opportunities to advance health, safety, and performance. This review examines emerging intelligent systems; AI, robotics, and automation and highlights how collaboration between humans and machines reduces hazardous exposures, enhances situational awareness, and drives data-informed decision-making. We map the impacts of these technologies across the mining life cycle and emphasize that their benefits depend on strong change management, workforce upskilling, and thoughtful integration to address resistance and psychosocial risks. Our findings provide actionable insights, key technologies, and guidelines for leaders and policymakers to embed safety-focused collaboration that protects workers while enabling efficient, sustainable mining.

10:05 am

Innovating Mining Safety – Leveraging Women's Unique Perspectives

J. Padgett, MOSH, CMSP, PHR; MSHA Safety Services, Inc., Benson, NC

Women in mining bring a unique perspective to safety—one rooted in collaboration, communication, and adaptive problem-solving. Their presence helps challenge traditional norms and encourages more inclusive safety policies that reflect diverse needs. From designing gear that fits female bodies to promoting a culture of care over compliance, women's contributions are reshaping risk management. Their advocacy not only strengthens safety outcomes but also empowers others in the workforce to prioritize well-being. As mining evolves, so does its approach to safety—and women are at the forefront of that transformation.

10:25 am

Safety Outcomes Optimized: Rocking Horse vs Rocketship

D. Musgrave; DEKRA North America, Atlanta, GA

Every organization has something in common, it's that their leadership team and workforce intend for no one to get hurt. Intentions are helpful when paired with the knowledge, skill, and cultural impact design to drive efficacious action and outcomes. This session highlights examples of large-scale safety and culture change and the key change maker tenets that made these successful, since many improvement initiatives fail to launch or simply amount to low-impact activity (rocking horse) that look like impactful action but don't yield meaningful change. This session highlights what to do, and how to make improvement in key areas. Learning Objectives: 1) Highlight required components for world-class safety outcomes and people protection 2) Learn from examples of effective change initiatives that brought valuable safe outcomes and reduced operational cost at the same time 3) Consider what gaps in achieving optimal safety performance still require attention and how to best approach these for continued improvement

10:45 am

26-062

Transforming Safety in Colombia's Underground Gold Mines: A Decade of Lessons from Occupational Accidents in Antioquia

J. Diaz Martinez[1], L. Ospino Ballesta[2] and O. Restrepo Baena[2]; [1]Martin Marietta, West Chester, OH and [2]Universidad Nacional de Colombia, Medellin, Antioquia, Colombia

The underground gold mining sector in Colombia plays a crucial role in national development but faces persistent occupational hazards that threaten worker safety. Despite its economic contributions, outdated technologies, limited risk management practices, and insufficient regulatory enforcement have led to recurring workplace accidents, many of which have been fatal. This study presents a systematic review of mining-related accidents in Antioquia between 2015 and 2025, the region with the highest concentration of underground gold mining in Colombia. Through geo-referenced analysis, high-risk municipalities were identified, and accident frequency was correlated with specific mining methods and operational practices. The findings underscore the urgent need for evidence-based interventions that are tailored to the region's unique mining context. Ultimately, this research contributes to the global discourse on mining safety by highlighting practical pathways to reduce occupational risks and promote safer, healthier workplaces in resource-constrained environments. Keywords: Underground gold mining, occupational safety, accident analysis, risk prevention, mining health.

Tuesday, February 24
Morning

HISTORY OF MINING II

150D-E

Chair: ***M. Hendrickson****, University of California San Diego, San Diego, CA*

9:00 am

Introductions

9:05 am

Words Matter: 100 years of Mining Discourse in Congressional Reports

K. Brown Requist; Tennessee State University, Nashville, TN

The way in which the mining industry is discussed within the United States Capitol has a major impact on domestic and international minerals policy as well as mining legislation. This data-driven analysis of the evolution of mining discourse within the US Congress uses natural language processing of congressional reports between 1924 and 2024. These congressional reports give key insight into the lawmaking process surrounding the mining industry and can provide insight into other political factors shaping mining discourse at the time of publication. Decade-over-decade trends are discussed in historical and political context. Further, the cyclical nature of mining discourse is analyzed, especially with topics of deep-sea mining and space mining.

9:25 am

Federal Mining Legislation – A History of Mine Disasters

G. Luxbacher; MELM Consulting, Dawsonville, GA

The Pennsylvania State Legislature enacted the Schuylkill County Ventilation Act, the first identified mining legislation in the United States, after hearing the ten+ years of appeals by miners in 1869, however it only pertained to one county in Pennsylvania. Following the September 6, 1869 Avondale mine disaster (108 miners and 2 rescuers perished in a mine fire) a law was enacted in 1870 covering the entire anthracite field. Fast forward 137 years to the passage in Congress of the Mine Improvement and New Emergency Response (MINER) Act of 2006, again an outgrowth of the Sago, Alma, and Darby mine disasters. This presentation looks at the progression of major legislation over those 137 years, bringing recognition to those who lost their lives in mine disasters and the legislation that has significantly improved miner health and safety in the United States.

9:45 am

Copper Follies

E. McCarthy; Performance Minerals LLC, Morgan Hill, CA

Between 1830 and 1930 the world copper market underwent enormous changes in production, technology, end uses and geography. In 1830 it was a specialized industry in Cornwall, Wales and Saxony with unique military and decorative uses. By 1930, it was the key world-wide commodity driving electrification, plumbing and automotive along with its traditional uses in military and church decoration. The United States and Latin America were now the major producers, but alternate sources had been developed in Europe, Australia, Asia and Africa, The story encompasses entrepreneurs, tariffs, free trade, technology shifts, international rivalry and war, as well as repeated efforts by major players to control copper pricing. The London Metal Exchange played a major role throughout the era, as did financiers like the Rothschilds, moguls like Agassiz, Rodgers and Ryan and German trading firm, Metallgeschellschaft. There were winners and losers, fortuitous and foolish, highs and lows, triumphs and tragedies. All in all it makes for a very interesting story.

10:05 am

The Role of Spanish and Hispanoamerican Scientists and Engineers to the Development of Mining and Metallurgical Science in the 18th Century

A. Tobar Escudero[1], S. Nowosad[2] and J. Parra y Alfaro[3]; [1]Epiroc, Coslada, Madrid, Spain; [2]Curtin University, Kalgoorlie, WA, Australia and [3]Universidad Politécnica de Madrid, Madrid, Madrid, Spain

This paper examines the contributions of Spanish and Hispanoamerican scientists to the development of mining and metallurgical science in the 18th century, culminating in the foundation of the Societät der Bergbaukunde in 1786. It highlights the work of Fausto de Elhuyar, as well as earlier Spanish figures such as Alonso Barba, whose innovations in beneficiation and metallurgical chemistry fostered transatlantic knowledge exchange. The study also explores the institutional role of the Bergakademie Freiberg, the Escuela de Minas de Almadén (later relocated to Madrid), and the Real Seminario de Minería in Mexico City in formalizing and standardizing mining education. Many founding principles of the Societät der Bergbaukunde—to which Spanish mining engineers and metallurgists made substantial contributions—remain highly relevant today, including innovation, collaboration, and transparency. These values continue to shape its present-day successor, the Society of Mining Professors (SOMP).

10:25 am

Mining in the US in the Age of Mineral Internationalism, 1970 to Present

M. Hendrickson; University of California San Diego, San Diego, CA

This paper marks the start of a new book-length project on the history of the US mining and mineral industry since the 1970s. In the early twentieth century, US miners produced an abundant supply of minerals that helped make it the world's largest economy and, according to economic historian Gavin Wright, "the world's dominant producer of every one of the major industrial minerals of that era." Since the 1970s, the US has often embraced a mineral internationalist understanding of its relationship to mineral supply chains that minimized the importance of domestic supplies of minerals. For instance, in 1984 the Chair of the Mineral Economics Department at Colorado School of Mines argued, "Countries like Japan and West Germany have very, very strong economies with very low levels of metals self-sufficiency." This paper examines the history of mining in the US in recent decades and deliberates on the significance of these recent changes in supply chains and mineral production. Among other sources, it draws on the work of the Regional Oral History Office's Global Mining Project at UC Berkeley and the more recent collection developed by the AIME's Oral History Project.

10:45 am

History of The Freeport-McMoRan Mineral Collection

W. Wilkinson; W. H. Wilkinson, L.L.C., Phoenix, AZ

Freeport-McMoRan Inc. is an international mining company with headquarters in Phoenix, Arizona. Created in 1981 through the merger of Freeport Minerals (formerly the Texas Freeport Sulphur Company) and the McMoRan Oil & Gas Company, Freeport-McMoRan is today one of the largest publicly owned copper mining companies in the world. In 2007, Freeport-McMoRan acquired the Phelps Dodge Corporation, among the oldest and most successful mining companies in Arizona, and with it came the historic Phelps Dodge mineral collection. Although a great many historic collections from early Arizona have been lost over the years (see Wilson, 2020), the Phelps Dodge-Freeport-McMoRan collection survives today, and has an interesting history, which can be traced through numerous old company documents.

Tuesday, February 24
Morning

INDUSTRIAL MINERALS & AGGREGATES: ADVANCED PROCESSING OF INDUSTRIAL MINERALS, TAILINGS, AND MINING WASTE

250C

Chairs: ***H. Patel****, FLSmidth, Midvale, UT*
S. Algharbi*, Riyadh, Saudi Arabia*

9:00 am

Introductions

9:05 am

Use of NanoFibrillated Cellulose for Rapid Thickening of Mineral Processing Outputs for Bulk Material Handling

K. Gourlay; Performance BioFilaments, Garibaldi Highlands, BC, Canada

This presentation will provide a brief overview of NanoFibrillated Cellulose (NFC), a recently developed high-performance additive derived from the mechanical refining of wood pulp. It will summarize key technical data demonstrating the material's thickening effects. Collaborative research and development programs involving various academic institutions and mining industry stakeholders have shown that even very low dosages of NFC can rapidly and significantly thicken a wide range of unconsolidated mineral particulates, including copper and iron ore concentrates, coal fine tailings, and oil sands tailings. NFC's exceptional thickening capability can substantially reduce—or even eliminate—the filtration time and energy required to produce a transportable cake, potentially debottlenecking facilities where dewatering is a major operational challenge. In addition, the presentation will briefly discuss the use of NFC in pelletizing and briquetting applications for ore processing.

9:25 am

Tailings Basin Designs with Jurisdiction and Environmental Challenges

N. Higgerson; Associate, St. Louis, MO

The project involved the potential construct of two new mine tailings basins at the mine. The basin footprints were initially 80 and 180 acres. Within the areas three streams were identified. These streams, and any other potentially present waters of the United States (WOTUS) within the construction footprint, will be impacted and/or rerouted, which necessitates Clean Water Act (CWA) permitting under Section 404 through the United States Army Corps of Engineers (USACE) and under Section 401 through the state agency. The new stream routes will require a design, including mitigation strategy, acceptable to the USACE and the appropriate state agency. This mitigation and rerouting of the creeks had to be accounted for in the design of the tailings basins to maintain the capacity required mine operations. To fulfill CWA requirements, Geosyntec identified potential WOTUS within the project area; potential threatened and endangered species and potential habitat; determined proximity to Federal Emergency Management Agency designated floodplains and floodways; identified state, municipal, and federally protected lands; and mapped cultural/historic resources from prior investigations.

9:45 am

Valorization of Phosphogypsum Using Steam Calcination

H. Ababneh and B. Dally; King Abdullah University of Science and Technology, Thuwal, Makkah, Saudi Arabia

Phosphogypsum (PG), a byproduct of phosphate fertilizer production, poses long-term environmental and storage challenges. Steam calcination offers several advantages over conventional thermal decomposition methods, including lower decomposition temperatures, enhanced reaction rates, and improved energy efficiency. Additionally, the process can be powered by renewable energy sources. Moreover, this approach generates valuable coproducts: calcium oxide, which can be used in various applications such as in cement production, and SO2-rich off-gas, which can be converted into sulfuric acid. To bridge the gap between laboratory feasibility and industrial deployment, this work scales up steam calcination technology for PG valorization to a few kilograms per day. Continuous trials in an electrically heated rotary kiln processing several kilograms daily will elucidate PG decomposition kinetics in a steam atmosphere. Steam–PG ratio, solids residence time, and temperature, will be systematically optimized to ensure high conversion rates while minimizing energy consumption. This study paves the way for advancing circular-economy objectives and supports the sustainable management of byproducts.

10:05 am

26-044

Wet Gravity vs. Dry Magnetic Separation: Strategic Trade-Offs in Rare Earth Ore Preconcentration

M. Sadeghi[1], D. Kinnes[2] and J. Reed[1]; [1]Mineral Technologies Inc., St Augustine, FL and [2]Wyoming Rare (USA) Inc., Lakewood, CO

This paper presents a comparative assessment of wet gravity and dry magnetic separation for preconcentration of allanite-rich rare earth ore from the Halleck Creek deposit. Ore in the -300/+86 μm size range was processed to develop a flowsheet targeting maximum total rare earth oxide (TREO) recovery. Quartz is the main gangue mineral, along with hastingsite—an iron-bearing aluminosilicate with properties similar to allanite—making separation difficult. Two technologies were evaluated: MG12 spirals for gravity separation and Induced Roll Magnetic Separator (IRMS) for dry magnetic separation. MG12 spirals performed well at the rougher stage but showed limited effectiveness at the cleaner stage. IRMS integration at the cleaner stage led to improved TREO upgrading and recovery, supporting its potential to replace the wet gravity circuit with a fully dry process. This study highlights the trade-off between high-throughput rougher separation and improved selectivity, water-free operation, and sustainability using dry magnetic separation.

10:25 am

What Makes Phosphogypsum a Resource, Not a Waste

M. Al-hawaree and A. Riad; Ardaman & Associates, Inc., Orlando, FL

Phosphogypsum is a by-product of the production of phosphoric acid from phosphate rock. Phosphogypsum is mostly stored on Phosphogypsum Stacks that occupy large areas and, if not properly designed and managed, can pose potential impacts on the Environment. The debate over whether the by-product Phosphogypsum is a waste or a resource has never ended since the beginning of the fertilizer industry. A review of Phosphogypsum classification and toxicity in several countries will be presented. An overview of typical Phosphogypsum physical and chemical properties will be summarized. Elements that may classify Phosphogypsum as a waste will be highlighted. Elements that can illustrate the potential beneficial use of Phosphogypsum will also be highlighted, along with a listing of beneficial uses. Special case history of potential application of extracting rare earth elements from Phosphogypsum will be presented.

10:45 am

Enhancing Mineral Processing Efficiency Through First-Principle Digital Twin and Advanced Process Control Integration

B. Hostetler; Member, Houston, TX

This study investigates optimizing mineral processing by integrating first principle digital twins with advanced process control (APC) strategies, particularly model-based predictive control (MPC). Digital twins enhance process efficiency, especially in brownfield operations, by facilitating real-time monitoring and simulation of nonlinear processes. The study discusses actionable insights, improving flexibility, and responsiveness in operations. Challenges such as model tuning and sensor reliability are also examined. Findings indicate that this integration can lead to sustainable production practices, while future research will expand digital twin applications within actual process units.

Tuesday, February 24
Morning

INDUSTRIAL MINERALS & AGGREGATES: ADVANCES IN PHOSPHATES AND POTASH: FROM BENEFICIATION TO DIVERSE END-USE APPLICATIONS

250D

Chairs: ***R. Hiremath****, Hexion Inc., Milford, CT*
K. Costner*, Intrepid Potash Inc, Carlsbad, NM*

9:00 am

Introductions

9:05 am

26-009

Application of a Novel APG Surfactant as a Tool to Enhance the Direct Flotation of Apatite

L. Moore; Colonial Chemical, South Pittsburgh, TN

With the decline in mineral feed grades, beneficiation will continue to face challenges. Challenges such as obtaining high recoveries of industry specified quality mineral concentrates, while using these lower quality feedstocks. One such mineral is apatite, which is required to meet the world's demand of fertilizer. The mining and processing of apatite continues to be the dominant pathway of yielding phosphorus-based fertilizers, which can include multi-staged flotation. The days of using standard saponified fatty acid-based collectors are over, due to the lack of selectivity with the increase of gangue minerals in these feedstocks. Collectors need enhancing. This presentation focuses on a novel alkyl polyglucoside type surfactant that can be blended with the standard saponified fatty acid collector in relatively low concentration to enhance the grade/recovery balance of the direct flotation of apatite. Flotation results as well as surfactant properties will be discussed.

9:25 am

26-042

On Improving Sulfides Flotation: The Use of a Phosphate Flotation Depressant, and Rheology to Enhance Collectors Performance

F. Sotillo; PerUsa EnviroMet, Inc., Lakeland, FL

Using a new ecological-natural-occurring organic depressant for gangue and pyrite with antibacterial properties (control of acid mine drainage) with new improved xanthate collectors using a rheology additive not chemically reacting with xanthate resulted in better sulfide flotation. Rougher-scavenger lead flotation tests were conducted increasing the concentrate grade from 7.07% Pb to 13.44% Pb, enhancing selectivity. Lead recovery increased from 64.08% to 79.38% and 80.40% using only the new depressant, and improved xanthates Z-11 and Z-4, respectively. The results demonstrated that the new depressant was selective and efficient, and the new-improved xanthates stronger and more selective collectors.

9:45 am

26-032

High-Frequency Screening of Iron Ore

H. Turrer[1], P. Pinto[1], M. Rodrigues Cruz[1], R. Winterfield[2], J. Wheeler[2] and B. Zhang[2]; [1]ArcelorMittal, London, United Kingdom and [2]Derrick Corporation, Buffalo, NY

Efficient particle classification is essential to enhance gravity and magnetic separation stages in one iron ore beneficiation plant. This study investigates the use of high-frequency screens to process finely ground iron ore, focusing on two size cuts: 400 μm and 100 μm. Pilot-scale trials were performed on four ore blends using a full-scale screening unit. A total of 48 tests were conducted, evaluating the effects of panel aperture, solids concentration, wash water, and feed particle size distribution. Results showed that wash water improved efficiency by up to 5%, while a solids concentration near 40% w/w delivered high separation performance with minimal ultra-fines in oversize streams. Apertures slightly larger than the target cut sizes yielded better precision in particle separation. Feed particle size distribution had limited impact on efficiency. The investigation successfully identified optimal screening conditions, including aperture selection, to achieve the most effective separation performance for downstream concentration processes.

10:05 am

3D Characterization of Salt Cores by X-Ray Computed Tomography to Understand Potash Solution Mining

J. Jin[1], P. Liu[1] and S. Gowen[2]; [1]The University of Utah, Salt Lake City, UT and [2]Intrepid Potash, Moab, UT

Every mineral phase has a specific linear X-ray attenuation coefficient, in X-ray Computed Tomography (a transmission 3D imaging technique). Understanding the 3D structures of potash phases in salt cores is important for designing solution mining in the underground. Although the specific gravity of sylvite is 1.99, slightly lower than halite 2.17, the significant difference in atomic number (K 19 vs. Na 11) enables the identification of sylvite from halite by X-ray computed tomography. Selected salt core samples were scanned using a Sigray Eclipse system at the University of Utah. The potash volumetric percentage, potash phase size distribution, and connectivity of the potash phase were reported. The permeability of salt cores by brine solution was simulated from the 3D structures using the Lattice Boltzmann Method.

10:25 am

Potash Handling System Retrofit for Increased Production and Reduce Maintenance Cost – A Case Study

J. Patel and J. Chavez Sagarnaga; Jenike & Johanson, Tyngsboro, MA

Problems in bulk material handling systems, such as material plugging and reduction in live capacity as well as wear and corrosion are not uncommon in the mining industry. These problems can drastically impact production, operation and maintenance costs in mining sites. If existing systems present these problems, often the option of retrofitting is more cost-effective than demolishing and build new. However, to achieve success, it is essential at the design stage not only to consider the bulk solids flow properties and the operating environment involved but also the structural demands and the constructability limitation of the site. A case study of retrofitting a potash surge bin to improve reliability, safety and life cycle cost will be presented discussing how critical considerations, even if minor, could be the culprits for a successful or failed project. Engineers in charge of the design, fabrication, construction and erection of bulk solids handling equipment will benefit from this presentation as they will be able to better understand the consequences of critical considerations made during the life cycle to retrofit bulk solids handling systems from design to installation.

10:45 am

Potash Fertilizer Production: From Exploration to Exploitation

T. Kiessling; ERCOSPLAN, Erfurt, Germany

Potash is a vital component of fertilizer, playing a crucial role in promoting crop growth, plant health and food production. Potash is considered a critical mineral in the US, and there are plans to increase the domestic production of potash due to its importance for agriculture and national security. The presentation provides a comprehensive overview of the global distribution of potash deposits, along with the commercial mining and processing technologies involved. It also discusses the common development cycle, from exploration to exploitation and production, as it pertains to actual projects.

Tuesday, February 24
Morning

MINING & EXPLORATION: GEOSCIENCE: CRITICAL MINERALS: NAVIGATING GEOPOLITICAL AND ECONOMIC CHALLENGES PANEL

255B

Chairs: ***C. McClung****, Rio Tinto Kennecott, South Jordan, UT*
L. Martin*, Veracio*

9:00 am

Introductions

9:05 am

Panel Session – Critical Minerals: Navigating Geopolitical and Economic Challenges

T. Brady[1], A. Gulley[2] and D. Wellman[3]; [1]Colorado School of Miners, Golden, CO; [2]U.S. Geological Survey, Washington, DC, DC and [3]Rio Tinto, South Jordan, UT

This panel explores the evolving landscape of critical minerals amid global geopolitical tensions and economic volatility. As nations race to secure supply chains for minerals essential to energy transition, defense, and digital infrastructure, this session offers strategic insights into how these factors influence the mining industry and discusses strategies for navigating these challenges to ensure a stable and sustainable supply of critical minerals. Panel presentors include Thomas Boundy, Andrew Gulley, and Dawn Wellman.

Tuesday, February 24
Morning

MINING & EXPLORATION: GEOSCIENCE: GEOSCIENCE WORKFORCE DYNAMICS: SKILLS, RETENTION, AND BUSINESS ADAPTATION PANEL

250E

Chair: ***C. Williams****, Rio Tinto, Tucson, AZ*

9:00 am

Introductions

9:05 am

Mining & Exploration: Geoscience: Geoscience Workforce Dynamics Panel: Skills, Retention, and Business Adaptation

K. Lawrence; Equilibrium Mining, Chandler, AZ

As the mining and exploration industry evolves, so too must its workforce. This panel session will explore the changing dynamics of geoscience workforce in the mining and exploration sector. Highlighting essential skill sets, generational shifts, the growing importance of interdisciplinary expertise, and effective strategies for retaining top talent, and how businesses can adapt to changing workforce demands to ensure a resilient and skilled workforce. Panel presenters include Karl Lawrence, Luke Cruwys, and Nikki Richards

Tuesday, February 24
Morning

MINING & EXPLORATION: INNOVATION & TECHNOLOGY: SUCCESSFULLY APPLIED CASES OF TECHNOLOGY, INNOVATION, AND ARTIFICIAL INTELLIGENCE IN MINING OPERATIONS

Sponsored by Newmont

255F

Chair: ***A. Nieto****, University of Utah, Midvale, UT*

9:00 am

Introductions

9:05 am

Integrating Mine Data Sources to Improve Grade Reconciliation and Ore Control Using Komatsu's High-Precision Systems

Y. Pango Rondon; Komatsu Mining Technology Solutions, Coquitlam, BC, Canada

The Canadian Mine showed interest in reconciling grade information (specifically Cu% and other minerals) from different data sources. The goal was to integrate information from different these sources to reconciliate tonnage and grade quality information with the objective of improving the accuracy of material selectivity using ProVision® high precision guidance system data, DISPATCH® fleet management system data, and shovel scan dig grade information to quantify ore loss and improve ore feed and blending control. This project was undertaken by the Komatsu MTS Professional Services group, and involved several important phases, which included: reviewing and understanding the mine geology data processes to integrate data from ProVision®, DISPATCH® and shovel scan dig grades with the current reconciliation reports, creating a robust process to integrate the information from different sources, planning and reviewing potential reports by bucket, truck, and material type, ensuring correct mine geology data processing, creating custom reports for reconciliation, and finally, designing a solid real time blending process using this data.

9:25 am

Innovative Technologies at the Santa Cruz Project to Advance Modern Mining

C. Shaw, G. Barr, Z. Oberling and T. White; Ivanhoe Electric, Herriman, UT

Within the scope of the Santa Cruz Project, innovative technological methods were evaluated to improve the efficiencies of large scale undeground mining. These technologies include road header decline development, silica gel injection, battery electric equipment, teleremote automation, and Railveyor materials handling. These advancements include innovative combinations of mining to process facilities which will contribute to peak performance of a high tonnage underground mining project.

9:45 am

Practical Innovations with BIM, VR, and 3D Printing

C. Haws and E. Bird; Cementation Americas, Eagle Mountain, UT

A retrospective on applying practical innovations to enhance complex project delivery through lessons learned and implementation guidance. Integrating advanced technologies in engineering and construction improves visibility, stakeholder engagement, coordination, safety planning, and efficiency. Building Information Modeling (BIM) centralizes project data in a dynamic 3D environment, enabling design visualization, coordination, and early constructability and safety reviews. This digital approach helps identify risks and conflicts early, improving predictability. Virtual Reality (VR) offers immersive design reviews in pre-construction, enhancing client interaction, design understanding, and data-driven decisions that reduce rework and improve constructability. 3D Printing enables physical prototypes of tools and components, supporting planning, sequencing, and continuous improvement in design and field work. Together, these tools form a collaborative framework that aligns teams, supports timely decisions, and drives measurable improvements in safety and delivery.

10:05 am

Beyond the Level: Subterranean Mapping Assisted by Autonomous Quadruped Robot with LiDAR and SLAM — Comparison with Conventional Methods and Case Evaluation in the Peruvian Andes

N. Portal Ravichaua; SME UNC, Cajamarca, Cajamarca, Peru

This study evaluates the functionality of an autonomous quadruped robotic system integrated with high-resolution LiDAR technology for three-dimensional mapping of underground environments and its potential use in medium-scale mining operations in the Peruvian Andes. The robot features a four-legged locomotion system capable of adapting to irregular surfaces and variable geomechanical conditions. The onboard LiDAR provides 360° scanning, emitting up to 600,000 laser pulses per second to generate dense point clouds processed in real time using SLAM. The system includes inertial sensors (IMU), RGB-D cameras, and a processing unit with autonomous navigation based on deep learning. A comparison was made between conventional underground mining surveying and the results obtained in preliminary tests of the robotic system, carried out in environments that replicate typical conditions of medium-scale underground mining in the Peruvian Andes. The results show a 60% reduction in survey time, greater operational safety, and millimeter-level accuracy in terrain models. A roadmap is proposed for its progressive integration into development, exploration, and geotechnical monitoring tasks.

Tuesday, February 24
Morning

MINING & EXPLORATION: MANAGEMENT: INTEGRATED VALUE STREAM PLANNING

255C

Chair: ***M. Austin****, Rio Tinto, South Jordan, UT*

9:00 am

Introductions

9:05 am

From Model to Profit: Enhancing Confidence in Resource Estimation

B. Jankovic; P.Geo, Springwater, ON, Canada

This presentation outlines key methodologies and practical insights that differentiate robust estimations from high-risk models, emphasising the integration of geological understanding, statistical rigor, and operational experience. At the core of every estimation lies the sample population defined by technical and economic constraints. which can distort interpretations if not addressed through proper de-clustering and validation techniques. It requires geological domain modeling that aligns with observed grade distributions and structural controls. Domains must exhibit internal stationarity and distinct spatial continuity, avoiding the mixing of population, grade variability and mineralization styles. We further explore statistical characterization of geoscientific databases, including strategies for handling grade variability, capping outliers, and ensuring data suitability for modeling. By aligning data quality, geological interpretation, and modeling discipline, we move from isolated estimates toward credible, profit-oriented resource models that support informed mine planning and investment decisions.

9:25 am

Measuring and Improving Predictability in an Iron Ore Mining Operation Using Stochastic Forecasts

G. Gariba and M. Faria; KPI Mining, Montreal, Quebec, Brazil

Reconciliation is a well-established process in mining to address geological uncertainty and variability due to limited orebody knowledge. Traditional estimation methods often misrepresent the spatial distribution of geological attributes, impacting mine planning forecasting accuracy. This study presents a case from an iron ore operation in Brazil, where geostatistical simulations of multiple grades supported stochastic optimization of the life-of-mine plan. Forecasts from deterministic and stochastic schedules in mined-out areas were compared to historical plant data. Results show improved reconciliation for contaminant grades using the stochastic approach, enhancing accuracy for critical contaminants in the downstream pelletizing process.

9:45 am

Strategic Planning Through Multimine Optimization: Lessons from a Large System at Vale

A. Barbosa Andrade, F. Damasceno Dias, P. Silva and R. Santos; Vale, Belo Horizonte, Minas Gerais, Brazil

Multimine optimization at Vale aims to integrate the entire value chain — from over 25 mines and 30 plants to multiple railways, train load-outs, and ports — into a unified decision-making model. This ambitious approach faces significant challenges, including complex model configurations, long runtimes, many assumptions to validate, and difficulties in analyzing and interpreting results across dynamic scenarios. Through iterative development, the focus shifted toward optimizing product blending and capital allocation by modeling economic value in greater detail and defining strategic decisions as value-driven triggers within the optimization process. Effectively managing model constraints proved equally critical, ensuring realistic outputs, reducing computational burden, and enhancing the reliability of strategic insights. Scenario tracking, standardization, and dynamic scenario generation emerged as key enablers of scalability, transparency, and responsiveness. This work presents the evolution of Vale's methodology, offering practical insights for mining companies pursuing value-driven, long-term planning and the optimization of strategic decisions under real-world constraints.

10:05 am

Optimal Pit vs. Robust Pit in Lerch's-Grossmann Pit Optimization

J. Heiner; Forte Dynamics, Bountiful, UT

Lerchs-Grossmann (LG) pit optimization has long been a foundational tool in strategic mine planning. It provides a structured way to define the ultimate pit limit that delivers the highest economic return based on a given block model. Traditionally, the LG algorithm is used in a deterministic manner, assuming fixed inputs and overlooking the real-world uncertainties inherent in geology and market conditions. This paper examines the distinction between the "optimal" pit, designed to maximize net present value (NPV) under fixed assumptions, and the "most robust" pit, which seeks to minimize downside risk and perform reliably across a range of potential future scenarios. By comparing these two approaches, we examine how their goals, methods, and applications differ, particularly in the context of long-term mine planning under uncertain conditions.

10:25 am

Mining Megaproject Strategies: The Power of Aligned Teams

J. Ladegard; Worley, Phoenix, AZ

In the mining industry, the execution of large capital projects is difficult, lengthy, and expensive. Industry data shows that infrastructure projects with budgets above $1 billion are delivered one year behind schedule and run 30% over budget. The growing size of capital projects is followed closely by an increase in strategy, design, procurement, and project execution complexity. This session will present a facilitated panel discussion with experts from mining and consulting companies on strategies to develop teams and successfully execute large projects.

10:45 am

26-033

Impact of Integrated Mine-Plant-Waste-Tailings Scheduling on Iron Ore Project Configuration

P. Silva[1], L. Damet[2] and K. Silva[3]; [1]Vale, Belo Horizonte, Minas Gerais, Brazil; [2]Vale Sa, Belo Horizonte, Brazil and [3]Vale Sa, Belo Horizonte, Minas Gerais, Brazil

The current situation of the global mining economy is increasingly focused on the utilization of materials previously discarded in the mining process. The waste, through new processing routes, is gaining new contours for use as high-value-added products. The strategic mine planning process has consequently had to adapt to the new economic reality. In standard scenarios, the focus was primarily on mine sequencing aimed at the highest economic return, with all infrastructure allocated as a necessity of mining. This work aims, in strategic planning, to configure and select the best composition of mining structures. The entire Mine-Plant-Waste-Tailings-Products chain will be considered as a factor in the sequencing of a multi-mine complex, in order to achieve the most sustainable utilization of the current mines' waste. The sequencing is based on concurrent flows of process configurations and capacities, structure sharing, and flexibility of feed types. These factors will guide the sequencing, which will be constrained by components such as waste and tailings, lithology feed relationships, and especially product composition through market specs, all while respecting shipping capacities.

Tuesday, February 24
Morning

MINING & EXPLORATION: OPERATIONS: EQUIPMENT MAINTENANCE: ENSURING EQUIPMENT RELIABILITY FOR PEAK MINING PERFORMANCE

250F

*Chair: **L. Sierra**, Nevada Gold Mines*

9:00 am

Introductions

9:05 am

Leveraging Equipment Performance Data for Enhanced Mine Planning

S. Avane and A. Anani; University of Arizona, Tucson, AZ

Current mine plans fail to account for variability and uncertainty in equipment performance metrics such as availability and utilization, causing deviations from production targets. This paper aims to develop realistic production plans using Discrete Event Simulation (DES) and a Hybrid Machine Learning-Stochastic Programming (MLSP). The DES (Monte-Carlo simulation) is used to obtain production targets by modeling factors such as equipment delays and breakdowns as probability distributions. The ML-SP is used to predict equipment availability and utilization from historical data and generate a production plan. A comparative analysis is conducted to evaluate method robustness and ability to predict realistic production plans.

9:25 am

Preventing Downtime and Reducing Costs: Leveraging Remote Condition Monitoring to Address Operator-Induced Equipment Strain

A. Lay; Monico, Seven Hills, QLD, Australia

This presentation explores the impact of operator-induced brake, transmission, and strut abuse on heavy mobile machinery, linking these behaviors to increased unscheduled downtime, lost productivity, unexpected maintenance, and operational expenses. Through case studies and performance data analytics, we highlight how remote condition monitoring solutions can identify early signs of operator misuse, allowing for proactive intervention and operator training. By conducting real-time root cause analysis before faults escalate, these solutions reduce and stabilize maintenance expenditure], extend equipment lifespan, and improve net asset productivity. Attendees will gain insights into leveraging remote monitoring technology to mitigate operational risks and enhance equipment reliability in challenging industrial environments.

9:45 am

Asset Performance Management – The Necessary Evolution in Mobile Mine Maintenance

J. Johnsen; Wenco International Mining Systems, Knoxville, TN

In the mobile mine maintenance industry, we continue to face persistent challenges: o High costs from unplanned downtime and emergency repairs o Uncertainty around how to interpret or trust the data we collect o Loss of technical expertise These challenges have persisted for years. While we've made progress-such as gaining accessing to onboard equipment data and leveraging tools like Oil Analysis, but the challenges remain. Machine Learning and AI are frequently presented as the future of mine maintenance. While they offer significant potential, they should be viewed as components of a broader strategy—not as standalone solutions. Through this discussion, we will present the concept of Asset Performance Management not just as a toolset, but as a practice, a philosophy, and a strategic approach to reducing the impact of these ongoing issues. The key is not to pursue solutions your organization isn't1 ready to support. Instead, evaluate where your team currently stands and implement structured, meaningful change that aligns with your capabilities and delivers measurable impact. Effective maintenance enables production, cuts costs, and boosts efficiency.

10:05 am

How Mine Site Observations Can Improve Daily Production Efficiencies

R. Riggle; Caterpillar Inc., Menomonee Falls, WI

In today's mining industry, technology drives operations, yet the full load-haul-dump-return cycle is often overlooked. Haulage costs can reach 45% of total expenses, but time to observe and optimize field practices is scarce. Miners, engineers, and managers face growing responsibilities, from safety and environmental concerns to cost control and performance. These demands reduce opportunities to assess daily operations. While technology advances rapidly, the traditional practice of observing and refining haulage, loading, and maintenance has diminished. Many sites share a common issue: insufficient time to identify and act on operational strengths and weaknesses through direct field observation and analysis.

10:25 am

Establishing a Reliable Shotcrete and Fibrecrete Program in Underground Mining

P. Schaefer; Jetcrete, Garner, NC

Abstract: Shotcrete and fibrecrete are critical components of underground mining ground support systems. Establishing a reliable shotcrete and fibrecrete program requires a disciplined approach to material selection, mix design control and robust QA/QC procedures which includes strength testing and thickness verification. Operator competency through structured training, effective supervision and embedded safety systems is essential. Equally important is the use of fit-purpose equipment for batching, transport and spraying supported by a proactive maintenance regime. This presentation by Jetcrete will outline the foundational elements required to manage a successful shotcrete & fibrecrete program in an underground mining environment.

10:45 am

Maintenance & Repair Process Overview

J. Hoffman; Caterpillar Inc, Tucson, AZ

The Caterpillar Maintenance & Repair Process model comprises of (10) processes. This presentation provides a review of how maintenance performance contributes to mine success and overview of the ten maintenance processes. The ten processes include: Planning & Scheduling, Backlog Management, Preventive Maintenance, Condition Monitoring, Repair Management, Component Management, Parts Management, Human Resources & Training, Performance Evaluation, and Continuous Improvement.

Tuesday, February 24
Morning

MINING & EXPLORATION: OPERATIONS: PARTNERING WITH OPERATIONS FOR SUSTAINABLE OUTCOMES: SURFACE AND UNDERGROUND (JOINT SESSION WITH HEALTH & SAFETY)

255E

Chairs: ***L. Walker****, Freeport McMoRan Inc, Morenci, AZ*
K. McCoy*, South 32, Corona De Tucson, AZ*

9:00 am

Introductions

9:05 am

Designing Safety into the Project Lifecycle: From Concept to Closeout

K. Severinsen; South32, Tucson, AZ

Safety shouldn't feel like a checklist item, it should be the blueprint for how we build and deliver mining projects. When safety is woven in from the very first concept, it does more than just protects people. It helps prevent problems before they start, keeps teams working smoothly, and saves time and money along the way. This paper explores how to build safety into every phase of a project, from early design reviews to contractor planning to the hustle of day-to-day execution. It's about making safety part of the plan, not an afterthought. Most importantly, it focuses on what matters most: making sure every worker goes home safe at the end of the day. When safety drives the plan, everyone wins—on time, on budget, and injury-free.

9:25 am

Unveiling the Challenges of Tunneling in the Himalayas: Lessons from Rock Burst Events

M. Emad; King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

Tunneling through the Himalayas is a process of ongoing exploration, affected by dynamic stress conditions and hostile geological complexities. These unstable parameters are often not detected during the design phase, sometimes resulting in catastrophic rock burst failures. This was evident in a recently completed hydroelectric project in Pakistan, in which twin headrace tunnels being excavated with tunnel boring machines (TBMs) faced a number of rock burst incidents. The incidents were the result of a conjunction of factors including in-situ and excavation-induced stresses, inherent rock type brittleness, unfavorable bedding orientations, and structural irregularities. Situated in the Himalayas—a region in one of the earth's most active tectonic zones—the project site is near the Main Boundary Thrust (MBT), an active fault with minor faults crossing the tunnels. All these geological complications render the setting more challenging than the Andes, the Alps, or any other mountain belt.

9:45 am

From Data to Decisions: Deploying a Geomechanical Digital Twin for Enhanced Risk Management and Communication at the Henderson Mine

J. Monsalve, C. Vanegas Palacio, C. Lemas-Pesqueira and S. Ferguson; Freeport McMoRan, Blacksburg, VA

Cave mines are complex systems with many interdependent components, making it challenging to track and manage geomechanical risks. At Henderson Mine, a geomechanical "digital twin" model has been developed to integrate production, cave development, geomechanical, and monitoring data into a cohesive analysis platform. This tool enhances the interpretation of rock mass behavior and improves communication with key stakeholders. By visualizing and analyzing real-time and historical data, the digital twin supports informed decision-making, enabling the engineering team to better understand ground response to operational changes. It also serves as a forecasting tool, enabling early identification and prioritization of geomechanical risks. The platform fosters collaboration between engineering and operations teams, enabling proactive planning and effective response strategies. This integrated approach ultimately improves safety, productivity, and the overall management of complex mining operations.

10:05 am

Comparative Study of Blast-Induced Vibration Prediction Based on Two Hybrid Models: AdaBoost-BOA and GBoost-BOA

M. Aghdamigargari, S. AVANE, A. Anani and S. Adewuyi; School of Mining Engineering and Mineral Resources, University of Arizona, Tucson, AZ

While blasting vibration is a critical environmental and safety concern in mining, its accurate prediction is challenging due to complex blast parameters. This paper compares AdaBoost and Gradient Boosting as machine learning methods, optimized with the Bayesian Optimization Algorithm (BOA), for predicting blast vibrations. A dataset of 373 with eight input parameters and their Peak Particle Velocity (PPV), was used, with the Yeo–Johnson transformation applied to improve data distribution. Model performances were evaluated using R-squared, RMSE, and MAE. The AdaBoost-BOA performed best with R-squared = 0.88, RMSE = 0.35, and MAE = 0.26, providing a reliable tool for safer, sustainable blasting design.

10:25 am

26-035

Impacts of Human Fatigue Impairments on Mine Equipment Operation Performance

V. Viterbo Christopherson[2], L. Walker[3], V. Viterbo[1] and H. Khaniani[4]; [1]Agencia JAX, Belo Horizonte, Minas Gerais, Brazil; [2]Freeport McMoRan Inc., Climax, CO; [3]Freeport McMoRan Inc., Phoenix, AZ and [4]New Mexico Institute of Mining & Technology, Socorro, NM

This research investigates how haul truck performance is affected by fatigued operators when working rotating shift schedules. Rotating shift schedules demand intentional fatigue management to ensure fitness for duty. Fatigue can manifest as drowsiness, microsleeps, cognitive decline events and can pose serious safety risks. Recent studies have discovered that 65% of haul truck accidents indicate fatigue as the main causal factor (Caterpillar Global Mining, 2022). This research focuses on identifying the relationship between fatigue and equipment response using sensor data and machine learning models. The goal is to potentially reduce fatigue related incidents to improve safety in mining operations.

10:45 am

The Impact of a Minute

J. Fernandez; Caterpillar Inc, Peoria, IL

In mining, every minute counts. This presentation explores how small, consistent actions can lead to significant long-term improvements in efficiency, safety, and profitability. By leveraging MineStar products and tools, customers can better understand where opportunities are to make smarter decisions that lead to compounding value over time.

Tuesday, February 24
Morning

MPD: CHEMICAL PROCESSING: PRECIOUS METALS

155E

Chairs: ***B. Carlson****, South Dakota School of Mines and Technology, Rapid City, SD*
S. Ndlovu*, University of Arizona, Tucson, AZ*
T. Gangadari*, Pennsylvania State University, University Park, PA*

9:00 am

Introductions

9:05 am

Optimization of Gold Recovery Through Flotation and Gravimetric Preconcentration of Gold-Bearing Minerals

E. Asencios; SME, Carmen de la Legua, El Callao, Peru

This study evaluates alternatives for improving gold recovery from a gold-bearing mineral sample from Puno, Peru. The mineral was characterized using chemical gold assays by the Newmont method, and the gangue minerals were characterized using transmitted light microscopy, identifying gold grades of 255 g/t in the coarse fraction and 2.29 g/t in the fine fraction. Quartz was identified as the main gangue with 34%, and phyllosilicates with 12%. Three flotation schemes were compared. The first consisted of direct flotation using Z-6 xanthate at a pH of 7.5, obtaining a final recovery of 7.29% Au. In the second, reverse flotation was applied as a pretreatment without a collector to clean the phyllosilicates, followed by direct gold flotation with Z-6 xanthate, obtaining a recovery of 45.57% Au. In the third scheme, gravimetric preconcentration was used with Falcon equipment, followed by the reverse and direct flotation tested in the second scheme, achieving a final recovery of 55.41% Au. It was concluded that the best treatment option is to use gravimetric concentration followed by cleaning of gangue by reverse flotation to achieve maximum gold recovery.

9:25 am

Enhanced Recovery of Gold from Refractory Ores via Cavitation-Driven Leaching

S. Ndlovu[1] and J. Mbayo[2]; [1]University of Arizona, Tucson, AZ and [2]University of the Witwatersrand, Johannesburg, Johannesburg, Gauteng, South Africa

Refractory gold ores pose major challenges to conventional cyanidation due to sulphide encapsulation, poor mineral exposure, and inefficient reagent use. This study evaluates cavitation-assisted leaching—specifically hydrodynamic (Jetleach) and ultrasonic cavitation, as an innovative approach to enhance gold recovery. Cavitation assisted processes achieved over 70% gold recovery within 2 hours, surpassing conventional methods (<60%). Optimization using response surface methodology yielded 87.5% recovery for Jetleach at 16 MPa, 31.6 mL/min oxygen gas, and 3.8 kg/t NaCN. Ultrasonic cavitation reached 91.3% at 200 W and 30–32.5 kHz. However, power >200 W caused silica gel formation, and frequencies >60 kHz degraded cyanide, reducing recovery. An optimal window was identified to balance power, frequency, and reagent stability. The results show that cavitation-assisted leaching, especially ultrasonic, offers faster kinetics, lower reagent use, and improved performance on refractory ores, highlighting its promise for industrial application.

9:45 am

Application of MSA, an Alternative Lixiviant for Iridium Leaching from Alkali Fused Scrap of Spent Dimensionally Stable Anodes (DSA)s

H. Kim, J. Lee, H. Jung and J. Ahn; Jeonbuk National University, Jeonju, Korea (the Republic of)

Iridium (Ir) leaching from alkaline fused scrap of dimensionally stable anodes (DSAs) was investigated using methanesulfonic acid (MSA), an alternative lixiviant. Alkali fusion of the scrap sample was conducted with Na_2O_2 at a 1:5 weight ratio (Ir scrap:Na_2O_2) at 700°C for 3 hours. Then, the samples were leached using various concentration of MSA from 1 to 10 M and hydrogen peroxide (H_2O_2) from 1 to 3 M at 80°C. The results showed that increment of MSA enhanced iridium leaching from 35% to 93% within 6 hours. The H_2O_2 concentration varied from 0 to 3 M at 5 M MSA, but Ir leaching efficiency were similar at 80°C. The highest Ir leaching of 99% was achieved by using 10 M MSA at 80°C.

10:05 am

Methodology for Gold Recovery from Refractory Ores Rich in Iron Minerals

O. Restrepo Baena, D. Chaverra and J. Ariza; Universidad Nacional de Colombia, Medellín, Antioquia, Colombia

Refractoriness is a mineralogical property that limits gold recovery to below 70–80% using conventional cyanidation. This study proposes a pretreatment methodology to enhance gold recovery from refractory ores rich in iron minerals. Characterization of the ore before and after treatment is essential to evaluate mineralogical changes. The relationship between pretreatment conditions, cyanide consumption, and gold/silver recovery during conventional cyanidation is also analyzed to determine optimal parameters. Several technologies exist—ultrafine grinding, bio-oxidation, chemical oxidation, roasting, pressure oxidation, and carbon adsorption/desorption—but are often limited by high capital and operating costs, or environmental concerns. This research explores a cost-effective and environmentally safer chemical oxidative pretreatment using an agitated aqueous solution, aiming to increase gold and silver recovery from refractory ores.

10:25 am

Valorization of Spent Furnace Bricks: A Pathway to Recover PGMs, Ni, Cu, and Co from Refractory Waste

I. Flores Aroni and C. Anderson; Colorado School of Mines, Golden, CO

The limited domestic supply of platinum group metals (PGMs), combined with increasing demand for critical base metals such as Ni, Co, and Cu, underscores the need to improve recovery strategies across beneficiation and smelting operations. Previous work at Sibanye-Stillwater has identified that certain smelting by-products, including spent furnace bricks, retain appreciable concentrations of these valuable metals, representing a potential loss if unrecovered. This project aims to develop a recovery circuit using physical beneficiation methods, including magnetic separation and froth flotation. Results from micro- and bench-scale testing will support a proposed flowsheet and evaluate the technical and economic feasibility of recovering these metals from refractory waste streams.

10:45 am

The Role of Carrier Gas in the Recovery of Precious Metals and PGMs during the Pyrometallurgical Removal of Selenium from Selenium-Rich Metallurgical Wastes

L. Sanchez-Calderon, W. Kirk, M. Madrigal, M. Assurian, M. Silwamba, J. Wijenayake, A. Luyima and L. Alagha; Missouri University of Science and Technology, Rolla, MO

Selenium-rich metallurgical waste by-product is typically generated during the refinement of copper anode slimes collected from electrochemical processes. This by-product, commercially known as "crude selenium", contains 90% selenium, along with precious metals, PGMs, and other critical elements. This study focused on the selective removal of selenium using a low temperature pyrometallurgical process in a specially designed furnace that employed different carrier gases to enrich PGMs and precious metals in the residue. The effectiveness of each carrier gas during the process was assessed and compared. The process was optimized through thermogravimetric analysis to identify optimal conditions for each gas. Key variables, including process time, temperature, and gas flowrate were evaluated for their impact on the process's efficiency and selectivity.

11:05 am

Fundamental Study on Iridium Recycling from Iridium Oxide Waste Materials

N. Smith and J. Lee; Colorado School of Mines, Golden, CO

Iridium is one of the platinum group metals (PGMs) used various applications in catalysts, chemical processing, and electronics. The global production of iridium is about 7.5 tons which is much smaller than other PGMs. Mostly it is produced in mines located in South Africa and refined forms are sold by only a few global companies. Dimensionally Stable Anode (DSA) is widely used for producing copper foil, electrodeposition of printed circuit boards (PCBs) and electrochemical treatment for water. The goal of the study is to recycle iridium metal from DSA and produce iridium metal that can create a circular economy. It is essential to investigate the pretreatment of the DSA, chemical processing, separation/purification, and refining processes. In this presentation, the pretreatment of iridium oxide and chemical processing that can dissolve iridium from its oxide forms. Different fusions and digestion methods combined with various lixiviant systems have been investigated to optimize the process. Detailed procedures and results will be presented and discussed.

Tuesday, February 24
Morning

MPD: CHEMICAL PROCESSING: RARE EARTH AND CRITICAL MATERIALS I

155D

Chairs: ***F. Liu****, Hatch Ltd, Salt Lake City, UT*
A. Chandra*, USA Rare Earth, Denver, CO*
M. Rabbani*, University of Nevada, Reno, Reno, NV*
S. Gostu*, Glencore, Stamford, CT*

9:00 am

Introductions

9:05 am

Development of a Carbon Negative Process for Comminution Energy Reduction and Improved Energy-Relevant Mineral Extraction

M. Free[1], X. Yang[1], R. Honaker[2] and W. Zhang[3]; [1]University of Utah, Salt Lake City, UT; [2]University of Kentucky, Lexington, KY and [3]Virginia Tech, Blacksburg, VA

This presentation highlights the progress of an ARPA-E project led by a multi-institutional team from University of Kentucky, Virginia Tech, University of Utah, West Virginia University, and Purdue. The project aims to develop a carbon-negative, energy-efficient process by integrating innovations in grinding, separation, and bio/heap leaching. The flowsheet targets both high- and low-grade chalcopyrite ores. Ore above cutoff grade is processed using CO_2-assisted grinding and novel media to enhance liberation. The liberated coarse particles are upgraded using HydroFloat™ flotation, which significantly reduced the amount of material reporting to ball mills. A small split of the high-grade ore is bioleached to cultivate a high Cu^{2+}/Ag^{+} adapted inoculum. This inoculum accelerates chalcopyrite oxidation and enables heap leaching of low-grade ore that would otherwise fall below the cutoff grade. Column tests of the low-grade ore showed 2.3 times increase in Cu recovery using the adapted inoculum. Bioleaching with CO_2 in air increased biomass organic carbon by 56% and improved Cu recovery by 25%. The integrated approach offers ~95% energy savings and ~50% lower carbon emissions.

9:25 am

Valorization of Acid Mine Drainage Impacted Waters through Protein-Enabled Rare Earth Element (REE) Extraction

D. Saran, A. Banerjee, T. Lankiewicz, E. Costa, K. Sorenson, K. Radloff and D. Stigers; Allonnia, Boston, MA

Valorizing rare-earth elements from wastewater remains a technical and economic challenge. Prior work identified microbes and proteins that can accumulate target metals, but the proposed solutions have not demonstrated economic viability. Allonnia's RE-Cover technology utilizes novel REE-binding-proteins attached to solid support to selectively complex with REEs in the presence of high levels of interfering metals found in wastewaters such as aluminum, and iron. Our ion-exchange like deployment allows for passive wastewater treatment while the REEs are retained in the column. The REEs are then eluted at significantly higher concentrations with minimal other cations resulting in a high purity tREE solution.

9:45 am

Selective Recovery, Separation, and Purification of Critical Transition Metals from Acid Mine Drainage and Aqueous Solutions

Y. Shekarian, E. Ajiboye, M. Rezaee and S. Pisupati; The Pennsylvania State University, University Park, PA

Manganese (Mn), cobalt (Co), nickel (Ni), and zinc (Zn) have been in the spotlight due to their significant role in clean energy transitions. Acid Mine Drainage (AMD) is a potential secondary source for these elements. Recovery of these elements from AMD through precipitation requires elevated pH (~9) or costly oxidizing reagents. This study advances the work by developing a process to recover Mn-Co-Ni-Zn from the complex matrix of AMD selectively. This process aims to overcome co-precipitation challenges and achieve high-purity metals, addressing key gaps in recovery technologies. A novel purification process based on a previously developed 3-stage AMD treatment process was designed to recover high-grade Mn, Co, Ni, and Zn products from AMD through aqueous processing with multiple cleaner steps and precise control of process parameters. The proposed hydrometallurgical flowsheet combines ozone oxidative precipitation, sulfide precipitation, DMG precipitation, and solvent extraction to achieve selective separation and purification. This refined approach offers a sustainable pathway for critical mineral production from a challenging waste stream.

10:05 am

Green and Selective Lithium Recovery from Spodumene via Mechanical Activation–Assisted Organic Acid Leaching

P. Sarpong; The Pennsylvania State University, State College, PA

Lithium demand has surged with the widespread use of lithium-ion batteries in renewable energy technologies. Spodumene is a primary lithium-bearing mineral of lithium extraction interest, due to its comparatively high grade and simple composition. However, conventional extraction methods are hindered by high acid consumption, significant co-dissolution of impurities, and challenges in purifying the leach liquor. This study investigates a selective and efficient lithium extraction process from spodumene using organic acid leaching, preceded by mechanical activation as a pretreatment. Organic acids, including citric, oxalic, malic, tartaric, and acetic acids, are evaluated for extraction efficiency and selectivity. Leaching kinetics and reaction mechanisms are examined through controlled leach tests, and solution chemical equilibrium modeling. Leach residues and effluents are characterized by SEM, XRD, XRF, and TGA. An economic assessment is conducted to determine the feasibility and cost-effectiveness of organic acids for lithium recovery. Findings aim to advance environmentally benign spodumene processing with reduced reagent consumption and improved selectivity.

10:25 am

Recycling NdFeB Magnets II: Production of REEs by Fused-Salt Electrolysis

M. Moro[1], P. Sarfo[2], T. Bayless[1], H. Huang[1], M. Caccia[3] and C. Young[1]; [1]Montana Technological University, Butte, MT; [2]Rio Tinto, Salt Lake City, UT and [3]Alfred University, Alfred, NY

Previous research showed neodymium metal production can be accomplished with fused-salt electrolysis using fluoride baths. This work is continued with a focus on using NdF_3 produced in another study (see previous abstract) by examining the effect of chloride. Results show that pure chloride systems do not work; however, the presence of fluoride enables production. Design of Experiment (DOE) studies were conducted to determine optimal amounts of fluoride. Compared to the previous research, the novel approach is more sustainable due to reduced energy requirements and lower reagent costs.

10:45 am

Selective Rare Earth Recovery and Separation Using a 3D-Printed Photopolymer Resin

X. Yang, W. Liu, C. Wang and G. Musgrave; University of Utah, Salt Lake City, UT

This study investigates the selective rare earth element (REE) recovery from complex aqueous solutions such as acid mine drainage and bastnaesite leachate using a novel 3D-printed ion exchange resin. The resin was printed by photopolymerizing methacrylic functionalized with di-(2-ethylhexyl) phosphoric acid (DEHPA) and printed into cubic lattice geometries with tunable porosity to optimize flow and packing density. Batch adsorption tests showed high REE recovery and stronger affinity toward mid- and heavy-REEs at lower pH. The adsorption capacity at room temperature reached 16 mg/g at a resin-to-liquid ratio of 12.5 g/L within 1 hour. Ion exchange column experiments demonstrated the separation of individual REEs based on differential breakthrough times, with heavier lanthanides retained longer in the lattice. Subsequent selective elution further fractionated REEs, which indicates both kinetic and thermodynamic control over the separation process. The printed sorbent maintained structural integrity over multiple adsorption–desorption cycles, and its adsorption performance was further evaluated under application-relevant conditions.

11:05 am

Expanding Methods to Enhance Rare Earth Elements Separations

M. Free, P. Sarswat, B. Schroeder and E. Sadler; University of Utah, Salt Lake City, UT

Rare earth elements (REEs) are critical to many important items we use daily. REEs are difficult to separate due to their inherent chemical properties. Magnetic susceptibility, chemical properties, and engineered materials can be used to enhance REEs separations in water. In addition, transport properties can be effectively applied in combination with magnetic forces, chemical attraction, and engineered materials to broaden separation capabilities. This presentation will discuss the associated principles and show results for enhanced REEs separations based on these approaches.

11:25 am

Fundamental Electrochemical Study on Neodymium Molten Salt Electrolysis in Fluoride Bath

F. Liu; Hatch Ltd, Salt Lake City, UT

The global demand for rare earth elements has surged due to their critical role in high-tech applications, including permanent magnets and motors used in wind turbines, electric vehicles, computers, and smartphones. Among these, neodymium and praseodymium are essential for manufacturing high-performance magnetic components. Ensuring a stable supply of these metals is vital for sustaining the clean energy and electronics industries. Currently, neodymium and praseodymium are produced via oxide-fluoride molten salt electrolysis. However, this process faces significant challenges, notably low energy efficiency and the emission of perfluorocarbon (PFC) gases, which are potent greenhouse pollutants. This study presents a fundamental electrochemical investigation into the properties of the molten fluoride electrolyte, focusing on oxide solubility and electrical conductivity. A mathematical model was developed to simulate and visualize the electrolysis process, providing insights into the underlying mechanisms. Experimental validation supports the proposed strategies to enhance energy efficiency and mitigate PFC emissions.

Tuesday, February 24
Morning

MPD: COMMINUTION: COMMINUTION I

155C

Chairs: ***S. Tripathy****, National Resources Research Institute, University of Minnesota Duluth, Grand Rapids, MN*
N. Blumberg

9:00 am

Introductions

9:05 am

Bond Award

9:25 am

26-010

Ball Mill Circulating Load: Characterization, Effects on Circuit Performance, and Optimization

R. McIvor[1], K. Bartholomew[1], O. Arafat[1] and E. Perez[2]; [1]Metcom Technologies, Hamilton, ON, Canada and [2]Corem, Quebec, QC, Canada

The "circulating load" is a nemesis to understanding the grinding circuits. Conflicting opinions exist as to its role. Should it be high, or low? Why does it even exist? It is commonly accepted in the plant as a given, the outcome of largely unknown factors. As such, it often goes unmeasured or even ignored. This paper describes the importance of the circulating load in wet ball milling circuits. It first is characterized not only in terms of solids mass flow (or ratio of mass flows), but also by its physical characteristics. Its effects on grinding circuit performance are explained. Then the equipment application design steps to achieve the desired circulating load, in terms of both its mass flow and physical characteristics, are described. Finally, its pivotal role in grind control is specified. The reader will come away with a fresh understanding of the role of the circulating load, including why and how it must be measured and managed.

9:45 am

Hydrocyclone Classification, Maintenance, and Operational Improvements at Montana Resources

P. Keyser; Weir Minerals U.S., Inc., Clinton, UT

Montana Resources, LLC desired to improve the overall performance of the rod mill/ball mill grinding circuit. By improving classification efficiency and designing for spare capacity, CAVEX® hydrocyclones resulted in lower fines bypass to the hydrocyclone underflow and reduced coarse solids to the overflow. This resulted in the elimination downtime attributable to the hydrocyclones, reduced maintenance expenses, and downstream benefits. Over the course of the initial six-month test period, Weir worked collaboratively with Montana Resources personnel and installed and operated CAVEX® Model 700CVX hydrocyclones, fitted with Weir NEXT intelligent solutions, on a single grinding line for the trial period. Results indicated that the goals of the trial were obtained. As a result the remaining grinding lines were retrofitted with CAVEX® hydrocyclones. Benefits included a marked decrease in hydrocyclone wear and, due to improved classification, an increase in flotation recovery.

10:05 am

26-023

Development of a DEM-CFD Coupled Power Model for Vertical Stirred Mills

M. Denzel, F. Wang, D. van Wyk and A. Boylston; Metso, Baden, Switzerland

Vertical stirred mills are increasingly used for fine grinding applications in the mineral processing industry due to their high energy efficiency. Thus, modelling power draw is of great interest proven by the effort in previous work including analytical models. In this contribution a DEM-CFD coupled model is presented to determine power draw under different operating conditions. These include grinding media filling level, shaft speed and fluidization as well as changes in grinding compartment configuration. An extensive test program on an especially equipped test mill is performed to validate the model.

10:25 am

Assessment of Angular Grinding Media on Copper Sulfide Ore Grinding and Flotation

K. Asgari[3], Q. Huang[1] and R. Honaker[2]; [1]Associate Professor, Morgantown, WV; [2]Professor, Lexington, KY and [3]PhD Candidate, Morgantown, WV

This study evaluated the impact of novel angular grinding media on the grinding and flotation of chalcopyrite. Compared to spherical media, angular media achieved a 16% finer P80 after 10 minutes and reached the 150 μm target 2 minutes faster, cutting energy use by 22%. It also reduced ultrafines (<37 μm) by 10%, enhancing flotation. Across tests, angular media consistently outperformed spherical media in energy efficiency and product fineness. The improved performance is attributed to its shape, which increases impact and lifting efficiency at lower mill speeds. Flotation tests showed 7–8% higher chalcopyrite recovery and 1–2% better concentrate grade. Particle shape analysis revealed higher angularity and lower sphericity, promoting better bubble-particle attachment. Results confirm angular media as a promising approach to improve grinding and flotation efficiency.

11:05 am

Lights, Camera, Action! Implementation of Particle Sizing Cameras at the Gold Quarry Roaster in Carlin, NV

A. Carver; University of Nevada, Reno, Reno, NV

In January 2025 the Gold Quarry Roaster (GQR) in Carlin, Nevada implemented Woodgrove Technologies Inc.'s Portage Characterization System (PCS), a camera and software suite that estimates the P80 and topsize of conveyed material using an image segmentation algorithm. PCS was instituted to track oversize throughout the grinding circuit, as oversize material in the ball mill is a leading cause of downtime. Three PCS cameras were implemented in June of 2025, after which I lead a robust sampling campaign. The results of this campaign indicated the PCS software routinely overestimated the proportion of oversize material camera by over ½". This presentation explores the operational and software challenges of integrating Woodgrove's PCS with pre-existing infrastructure at GQR, and on practices developed during this project to increase our operators' buy-in on the benefits of real-time particle size monitoring; additionally, I will address the actions taken to incorporate calibrated F80 information into AwaRE's alarm system, results on tonnage re-crushing and mill oversize events following the implementation of these alarms, and on collaborations with Woodgrove to improve the PCS software.

Tuesday, February 24
Morning

MPD: FLOTATION: INTERPRETATION OF GEOMETALLURGICAL LABORATORY FLOTATION TESTING FOR OPERATIONAL PREDICTABILITY

155F

Chair: ***I. Coltrin****, FLSmidth and Co A/S, Midvale, UT*

9:00 am

Introductions

9:05 am

26-034

Impact of Xanthate Collector on Secondary Sulfide High Clay Ore in Chino Mine

S. Chaganti and C. Beaven; Metallurgist with Freeport McMoRan, Silver City, NM

This study explores how switching from Thiophosphate to Xanthate collectors affects copper recovery from high-clay, secondary sulfide ore at the Freeport-McMoRan Chino Mine. Lab tests showed that Xanthate 1 achieved copper recovery comparable to Thiophosphate (up to 82.5% vs. 83%), while Xanthate 2 consistently delivered better recovery—improving by an average of 2.2%—and more stable results, particularly under high-clay conditions. A plant trial confirmed these findings, showing an improvement in copper recovery. These results suggest that Xanthate 2 is a more effective and cost-efficient option for this type of ore, making it a practical choice to improve flotation performance and reduce recovery variability.

9:25 am

26-046

Performance Comparison of Di Thiophosphate Collectors for Copper Ore Flotation

G. Prishmont, I. Douglas, M. Mohanty and J. Thella; University of Nevada, Reno, Reno, NV

The flotation performance of Sodium O, O-diisobutyl Di thiophosphate (referred to as reagent A) was compared with Aerophine 3418 (referred to as reagent B) for floating a complex copper ore grab sample. Preliminary test results indicated a cumulative copper concentrate grade of 10.19% with a recovery of 86.31%, which was achieved with reagent A from a feed consisting of 5.32% Cu. The grade and recovery achieved using reagent B from a feed consisting of 4.89% Cu are 9.11% and 87.85%, respectively. A comparative analysis based on the preliminary test results indicated that reagent A's performance is better than that of reagent B at lower concentrate grades, specifically below 12%. However, the flotation performance is better for reagent B at higher concentrate grades. A more detailed study is ongoing to optimize the grade-recovery performances achievable from both reagents. The results of this study will be the subject matter of this presentation/publication.

9:45 am

Optimizing Zinc Production at Red Dog Mine through Geometallurgical Modeling

F. Laroche; Teck Resources, Kamloops, BC, Canada

This presentation provides a geometallurgical overview of the Red Dog Mine, one of the world's premier zinc operations located in northwest Alaska. We explore the integration of geological, mineralogical, and metallurgical data to better understand ore variability and its impact on processing performance. Emphasis is placed on how geometallurgical modeling supports mine planning, enhances production forcasting, and improves operational efficiency. Attendees will gain insights into the site's unique geological setting, orebody characteristics, and the role of geometallurgy in bridging exploration and processing. This holistic approach is key to optimizing resource value and sustaining long-term production at Red Dog.

10:05 am

Mechanical or Pneumatic Flotation Cells: Which One Floats to the Top?

S. Roy and K. Rushdi; Fluor Canada Ltd, Vancouver, BC, Canada

Conventional mechanical flotation technologies have undergone exponential growth in size to accommodate the volumetric requirements for processing higher mill throughputs. However, flotation tank sizes may have reached a tipping point since they tend to waste input power during slurry mixing processes. While conventional cells perform excellently within a narrow band of flotation feed particle size distribution, they face challenges with coarser (>200μm) and finer size fractions (<20μm). This has led to a paradigm shift away from conventional cells, which gives a change for the innovative alternatives such as HydroFloat, DFR/SFR, Jameson/Concorde Cell, Reflux cell and StackCell etc. This presentation provides a comparative analysis of Mechanical and Pneumatic Flotation Cells, highlighting their respective advantages in reducing plant layout footprints, optimizing energy consumption, minimizing environmental impact, eventually lowering capital investment. It also addresses the key challenges associated with integrating these technologies into existing processing operations.

10:25 am

Advanced Flotation Solutions for Sepon: Boosting Concentrate Grade and Fine Particle Recovery in Gold Processing

A. Luke[1], H. Thanasekaran[1], G. Huang[2] and M. Behre[1]; [1]Eriez Manufacturing Co., Erie, PA and [2]Lane Xang Minerals Limited, Vientiane Capital, Lao People's Democratic Republic

The Sepon Gold Mine in Laos initiated an investigation to improve both concentrate grade and overall fine particle recovery from complex gold-bearing sulphide ores. Eriez Cavitation Tube and StackCell technologies were piloted and integrated into the flotation circuit to address these challenges. The Cavitation Tube, known for generating ultra-fine bubbles and high shear conditions, enhanced particle-bubble interaction, particularly for fine and liberated gold particles. The StackCell provided a two-stage flotation environment, combining rapid particle collection with a quiescent froth zone to reduce entrainment and improve selectivity. Pilot and site trials demonstrated a significant increase in fine particle recovery and an improvement in concentrate gold grade by 4–6 g/t, with improved overall recovery. The compact design and low energy consumption of these technologies also offered operational efficiencies. This study demonstrates the results from the site-based piloting works and industrial scale results.

10:45 am

Study of the Influence of Granulometry, pH and Reagents Dosage to Improve Copper Recovery by Flotation From an Oxidized Mineral With the Presence of Atacamite in the Ica Region, Peru

S. Cordova Melendez; SME, Lima, Lima, Peru

In Peru, Ica region, there is a copper sulfide flotation plant where recovery is greater than 80% using conventional methods and reagents. However, when mining a new area of the deposit, recovery dropped below 30%. The study begins with a geometallurgical characterization of the mineral using sequential copper, atomic absorption, and X-ray diffraction tests. After determining that there is a high presence of copper oxides with the Atacamite mineral in greater quantities, the influence of pH, granulometry, and reagent dosage was studied using a factorial design to optimize copper recovery. It was determined that the best option for copper flotation from an oxidized ore containing atacamite was to apply sulfidization with NaHS at doses greater than 800 g/t in combination with a strong collector such as Z6 (120 g/t) and a hydroxamate oxide collector (400 g/t), rigorously controlling the oxidization-reduction potential (< -350 mV), pH between 9 and 10, and the combined dosage of pH and silicate depressant. In this way, it was possible to achieve a maximum copper recovery of 78%.

11:05 am

An Investigation of Different Mechano-Chemical Strategies Combined with Flotation for Regenerating Battery-Grade Graphite from Spent LIBs

A. Sayem, X. Yang and J. Jin; University of Utah, Salt lake city, UT

Efficient recovery of graphite from spent Lithium ion batteries (LIBs) is vital for establishing a circular battery economy. This study investigates physico-chemical and mechanical processes for regenerating battery-grade graphite from black mass received from a LIB recycling plant. The process integrates sonication treatment and advanced flotation to enhance separation efficiency and product purity. Thermogravimetric analysis confirmed substantial PVDF removal, reducing binder content from 7.5% in raw samples to approximately. 2% in samples below 420 μm size. Major flotation parameters were determined via Design Expert software, identifying pH, collector, and wet grinding as statistically significant. The effects of flocculants, dispersants, depressants, and their combination on flotation performance were further evaluated, resulting in over 10% graphite grade improvement. After minor chemical treatments, the final graphite concentrate exceeded 95% purity, validated through ash analysis, XRD, SEM-EDS, and Raman spectroscopy. A subsequent thermal treatment restored crystallinity, producing regenerated graphite comparable to commercial grade.

11:25 am

Enhanced Sulfidization Flotation for Nickel Recovery from Mine Tailing

G. Kodali[1], X. Wang[2], J. Jin[2] and L. Pan[3]; [1]Graduate Research Assist, Salt Lake City, UT; [2]The University of Utah, Salt Lake City, UT and [3]Michigan Technological University, Houghton, MI

This study explores a comprehensive flotation strategy to recover nickel and copper from mine tailings, focusing on surface chemistry behavior and practical flowsheet development. Flotation Experiment were conducted to assess the effects of pH, activators, sulfidization, and mixed collector systems under varying flotation conditions. Contact angle measurements were used to evaluate mineral hydrophobicity, revealing key insights into the role of CO_2 and air environments in flotation performance. To advance practical application, flowsheet-based flotation experiments were performed to develop sequential flotation stages, aiming to enhance grade and recovery. The study highlights the importance of integrating surface chemistry understanding with process optimization to develop sustainable and efficient critical mineral recovery routes from low-grade, oxidized tailings.

Tuesday, February 24
Morning

MPD: PLANT DESIGN: PLANT DESIGN & OPTIMIZATION I

Grand Blrm D

Chairs: ***E. Wingate****, Bechtel Mining & Metals, Fortitude Valley, QLD, Australia*
J. Trouba*, Gopher Resource, St Paul, MN*

9:00 am

Introductions

9:05 am

The Ideal Sampling System That Never Was

M. McCaslin; McCaslin Consulting LLC, Murray, UT

In future, engineers and managers will likely continue using sampling methods that do not adhere to Theory of Sampling (ToS) standards. While we may criticize the abandonment of ToS when making sampling decisions, we must recognize that considerations unrelated to the representativeness of the samples often prevail. Unfortunately, there is little science to help decision-makers understand how far non-representative samples may deviate from reality. Although it's unlikely that we will find guidelines to gauge how much a device or approach will skew our data, further research into things like sampling errors, the impact of material characteristics on sampling, and the relationships between sampling and the data being gathered would yield useful insights. ToS is an excellent tool that informs us how best to obtain characteristic samples. This presentation is a call for academia, students, and other research entities to devote more time and resources to uncovering some of the fundamentals that affect representativeness. Furthermore, it is a call to sampler manufacturers and related businesses to support such research through funding, field information, and problem definition.

9:25 am

Scrub n' Sort: Producing A Dry Rare-Earth Mineral Concentrate Through Preferential Breakage, Ore Scrubbing, And Rock Sortation At The Bear Lodge Hardrock Project

C. Gorski and E. Spiller; Colorado School of Mines, Peyton, CO

The Bear Lodge project is set to become one of the largest producers of Nd-Pr oxide in the United States. The Department of Energy, recognizing this, has funded Bear Lodge's mineral processing research through the Critical Materials Innovation Hub. This research focuses on producing a dry RE mineral concentrate through 'preferential processing'. Preferential processing enhances flowsheet efficiency by pairing orebody characteristics with unorthodox unit operations to reduce expenditures. At Bear Lodge, the deposit's natural stockwork mineralization 'preferentially liberates' ore minerals when scrubbed, producing a RE concentrate with minimal comminution. The subsequent scrub-and-sort flowsheet has experimentally produced a concentrate grade of 10%+ TREO, with the potential to recover 90%+ of the ore's RE value without water, challenging traditional mill circuits & offering both a lower CAPEX & OPEX than traditional RE processing facilities.

9:45 am

"You Gotta Keep 'em Separated" – Unlocking the Benefits of Wet Screening

S. Skjonsby; CIM, Sudbury, ON, Canada

Wet screening improves mineral processing by washing fines, breaking agglomerates, reducing heat, and slowing particle velocity. Wet screening is ideal for removing contaminants and ensuring a sharp particle size distribution. However, designers often prefer dry screening or hydro-cyclones over wet screens due to concerns about water balance in grinding circuits. Poor water control can significantly turn a mineral processing circuit upside down, and quickly erase the benefit of a wet screen. Despite this, wet screening remains a viable option when supported by the right tools and equipment. This presentation explores common sense & practical solutions to make wet screening effective, reliable and more desired in mineral processing circuits.

10:05 am

Investigating the Crush Size Effects on Lithium Deportment and Gangue Rejection through Heavy Liquid Separation of Spodumene Ore: Implications for Dense Media Separation

B. Cook, M. Aghamirian, S. Pedraza and H. Walqui; Metallurgy, Belmont, NC

Hard rock lithium deposits, particularly spodumene-bearing ores, are key sources of lithium due to their high-grade and scalable processing potential. This study evaluated the heavy liquid separation (HLS) performance of spodumene ores at different crush sizes to define a dense media separation (DMS) circuit. The results indicated that finer crush sizes enhanced spodumene liberation and recovery, while at coarser crush sizes, losses were slightly increased to insufficient spodumene liberation. A 3/8" crush size was selected as it provided good recovery with minimal lithium losses. Other considerations, like flotation feed grade and the DMS bypass fraction are also discussed.

10:25 am

Flow Property Testing for Flow Sheet Development: When Should Material Testing be Done?

J. Nowoselski; Jenike & Johanson, Mississauga, ON, Canada

It is generally understood that knowing the flow properties of a material is critical for developing processing plant systems that are free of material handling issues. However, the evaluation of material's flow properties is not typically considered until the detailed engineering stage of the project when processes have been defined and general layouts are in place. At this point, changes to the flow sheet can be very costly, and are likely to cause significant delays. Knowing the flow properties of your material earlier can allow you the flexibility to make smart choices during the development of the process and prevent material handling challenges from arising at a later stage of the project. So when in the flow sheet development process should testing occur? In this presentation, we will go through several case studies that explore how flow property testing fits into the flow sheet development process.

10:45 am

Make the Most Out of Record Throughput

G. Yeung; Burns & McDonnell, Mesa, AZ

Existing mining operations are experiencing lower feed grades, prompting many companies to push record throughputs through comminution circuits to maintain metal production. However, this approach is often unsustainable due to limitations in current utility infrastructure and downstream processes, which lack the capacity to meet the increased demand. Spillage, accelerated wear, mechanical failures, and suboptimal operating parameters can lead to excessive metal losses to tailings. This presentation will explore common consequences during ramp-up periods and outline methods site metallurgists and engineers may consider to proactively address bottlenecks.

11:05 am

Developing a Real Time Roaster Efficiency Model for Double Refractory Gold Ores

D. Steiner, A. Lapointe and J. Hanks; Nevada Gold Mines, Elko, NV

Increases in plant throughput at Carlin's Gold Quarry Roaster have made short interval roaster circuit sampling necessary to measure organic carbon and sulfides and give control room operators quicker feedback on oxidation performance than previous 12 hour sampling. The next step is to combine assay and plant instrumentation data to generate a model for optimal molten sulfur and sulide con addition, using oxygen, temperature, and bed depth trends. The goal is to minimize tph based recovery impacts and optimize reagent consumption. This presentation will discuss progress made on Roaster Efficiency Modeling and potential improvements identified to further shorten the sampling interval and increase the predictive accuracy of the model.

Tuesday, February 24
Morning

RESILIENT ENERGY IN MINING: BALANCING TRADITION AND TRANSFORMATION: PROCESSING POWERS PROGRESS

Grand Blrm B

Chair: ***S. Shuey****, Retired, Highlands Ranch, CO*

9:00 am

Introductions

9:05 am

Increasing Iron Ore Grade Using High-Pressure Slurry Ablation: Pathways to Green Steel

T. lundquist[1] and G. Sweetwood[2]; [1]Disa Technologies, Frederic, WI and [2]Aggregate Mineral Resources, CERRITOS, CA

This study summarizes results from a collaborative test campaign between Aggregate Mineral Resources and DISA Technologies evaluating the application of High-Pressure Slurry Ablation (HPSA) for iron ore beneficiation. The campaign focused on three key material streams: magnetic separation middlings, run-of-mine (ROM) ore, and WHIMS concentrate, each processed using HPSA with high-gauss magnetic separation. Across all feed types, HPSA significantly upgraded Fe content while reducing impurities, achieving concentrate grades over 69% Fe from ROM and delivering double-digit Fe increases in middlings and a 9% increase in concentrates. These results were achieved at much coarser particle sizes than typical iron ore processing with HPSA ROM p80 exceeding 500 microns. By leveraging particle-to-particle collisions to induce intergranular fracturing, HPSA enables efficient liberation without the high energy demands of traditional milling. Its modular, scalable design provides a low-impact solution for unlocking value from primary and secondary ore streams. These results highlight HPSA's potential as a transformative technology for future low-carbon, high-efficiency steel production.

9:25 am

Rethinking Innovative Applications at Tailings Reprocessing Sites

J. Kellner[2] and A. House[1]; [1]Paterson & Cooke, Helena, MT and [2]Regeneration Enterprises / Rio Tinto, South Jordan, UT

Regeneration Enterprises is a public benefit company focused on providing business model, technological, and operational innovations in the mining industry to solve mine waste problems. Regeneration has developed offtake partnerships, characterization methods, financial strategies, and engineering design criteria that aim to apply novel approaches to a lasting industry problem. The Mariposa Flats project in Hedley, British Columbia highlights these approaches. The site is home to a historic mining town, mill site, and tailings disposal facility that has supported the industry from the late 1800s through present day. The tailings and mill facilities pose a significant contamination risk to the surrounding land, air, and water resources. Previous attempts to reprocess the gold-bearing tailings to generate value and an economic driver for the community failed and compounded mistrust with the Upper Similkameen Indian Band (USIB) and local community. Now, employing their unique approach, Regeneration has partnered with the Province of British Columbia and the USIB to address the site holistically, repair previous missteps, and restore trust and tradition to Mariposa Flats.

9:45 am

Copper Flat Recharged: Harnessing Innovation and Green Technology to Power a Sustainable Future

R. Srivastava[1], M. DhePaganon[1] and S. Crosby[2]; [1]WSP, Tucon, AZ and [2]New Mexico Copper Corp., Albuquerque, NM

The Copper Flat Mine in Sierra County, New Mexico, is a brownfield redevelopment project focused on extracting copper, molybdenum, gold, and silver from a porphyry-copper deposit. Operated by New Mexico Copper Corporation (NMCC), a subsidiary of THEMAC Resources Group, the project seeks to revive a site that briefly operated in the early 1980s. As global demand for copper and other critical minerals increases—driven largely by clean energy technologies—Copper Flat presents an opportunity to meet strategic needs while contributing to regional economic development. However, the project faces regulatory, environmental, and water rights challenges. NMCC is addressing these through a commitment to sustainable mining practices, advanced technology integration, and proactive collaboration with regulators, stakeholders, and local communities. By leveraging existing infrastructure and aligning with national critical mineral priorities, Copper Flat exemplifies how legacy mines can be responsibly redeveloped to support both resource security and environmental stewardship in a rapidly evolving energy landscape.

10:05 am

Microbial Community Succession in Chalcopyrite Leach Columns Underlines Benefits of Biological Process Control

S. Christel, T. Schumacher, P. Cline, R. Hodges, C. Green and L. Dennett; Endolith, Arvada, CO

Iron and sulfur oxidizing microbes drive solution chemistry and heat generation in sulfide leaching, yet their viability and performance remain a black box for operators seeking to optimize leach parameters at commercial scale. To highlight the limitations of unmanaged, ore-native microbes versus Endolith's continuous bioaugmentation approach, leach tests were conducted in 1 kg columns containing low-grade chalcopyrite ore. Columns irrigated with synthetic raffinate were ramped from 30–65 °C to simulate microbial pyrite oxidation and sacrificed between 21–105 days to correlate microbial community composition with leachate chemistry and residue mineralogy. Bioaugmented columns consistently exhibited higher oxidation/reduction potential across the temperature gradient, indicating enhanced microbial activity and heat generation. Ongoing 16S community profiling is expected to confirm faster establishment and greater adaptability of Endolith inoculants. Recognizing the need for clearer indicators of microbial performance and its influence on copper recovery, Endolith is developing SentinelHeap, a bioheap monitoring platform integrating microbial, geochemical, and operational data.

10:25 am

Selective Pretreatment of Lithium Clays to Reduce Acid Consumption and Improve Leach Kinetics

J. Floyd, T. Schumacher, M. Olichney, A. McCabe, R. Hodges, C. Green and L. Dennett; Endolith, Westminster, CO

Lithium-bearing clays including smectites and illites present major challenges to economic extraction due to carbonate gangue, which increases acid consumption and reduces the availability of acid for lithium recovery. Endolith presents a selective pretreatment method that removes >80% of carbonate phases at ambient temperatures in under one hour. Our approach improves lithium recovery, leach kinetics, and reagent efficiency across multiple ore types. Performance gains have been demonstrated using both conventional sulfuric acid leaching and Endolith's biological leaching alternatives. Treated clays exhibit shorter extraction periods, reduced gypsum-related downtime in sulfuric systems due to calcium removal prior to acid contact, and simplified downstream purification enabled by upfront gangue removal. This pretreatment approach is readily compatible with existing leaching strategies and expands the viability of domestic, clay-hosted lithium resources previously hindered by gangue burden. This DOE-supported technology has been demonstrated at pilot scale, with ongoing technoeconomic modeling guiding its integration into commercial flowsheets.

10:45 am

Innovative Technologies to Improve Recovery and Save Energy in NonFerrous and Precious Metal Mineral Processing Plants

W. Berends[1] and O. Mejia[2]; [1]Lycopodium, Brechin, ON, Canada and [2]Lycopodium, Mississauga, ON, Canada

Diminishing ore grades, rising energy costs, and volatile prices for nonferrous and precious metals necessitates the implementation of energy-efficient mineral processing plants with optimized metal recovery. This paper presents the strengths vs. weaknesses of recent mineral processing innovations including the use of High Pressure Grinding Rolls, Coarse Particle Flotation and High Intensity Flotation. Thorough metallurgical testing with these processes to determine metal recovery versus ore grade and throughput, combined with estimated CAPEX & OPEX, enables a trade-off evaluation of their economic benefits over the life of mine.

Tuesday, February 24
Morning

TAILINGS MANAGEMENT: HEAP LEACH HORIZONS: INNOVATIONS, FAILURES, AND THE FUTURE OF DATA-DRIVEN DESIGN

Sponsored by Newmont

155B

Chairs: ***S. Abbaszadeh****, Stantec, Denver, CO*
C. Winckler*, Anglo American plc, St Augustine, FL*
S. Li*, University of Utah, Salt Lake City, UT*

9:00 am

Introductions

9:05 am

Heap Leaching Operations – From Ideal to Not-So-Ideal Conditions

C. Strachan; Stantec, Fort Collins, CO

This presentation summarizes ideal conditions for heap leach operations as well as not-so-ideal conditions. In the early 1980s, heap leaching became a viable alternative to conventional mill processing for precious-metal recovery. This was due to reduced operating costs, allowing precious-metal recovery to take place over longer periods of time and processing of lower-grade ore. Ideal conditions for heap leaching include movement of leach solution through the ore in an unsaturated condition, which enhances precious-metal recovery, and provides a stable heap. Deviations from ideal conditions include leaching fine-grained ore, operating in wet or cold environments, or inconsistent application of leach solution.

9:25 am

The Eagle Gold Mine Heap Leach Failure of June 24, 2024

M. Smith; RRD International, Incline Village, NV

On June 24, 2024 the Eagle Gold mine valley leach facility experienced one of the most catestrophic slope failures in heap leach history, releasing 12 million tonnes of leached ore and process solution which contaminated local groundwater, as well as surface waters up to 27 kms away. The mine and processing facilities have since been shut down, the owner, Victoria Gold Corp, moved into receivership, and over C$200 million has been spent so far on the site's remediation. In August 2024 the Yukon government and the Receiver established an Independent Review Board to determine the geomemchanical causes of this failure. The report of that investigation was completed on June 30, 2024, and this presentation will give a overview of the failure, the key findings of and recommendations from the IRB investigation.

9:45 am

Unveiling Heap Leach Construction in an Age of Data and AI

A. Young; University of Utah, Salt Lake City, UT

In a world pulsing with machine vision, predictive algorithms, and sensor-laden landscapes, heap leaches remain a paradox. They are often massive, engineered artifacts, constructed in chaos and neglected by capitalism. This paper explores the mechanistic underpinnings of their construction and aligns them into a more wholistic, digitally compatable picture. It asserts that amid the rising tide of data science and AI-driven metallurgical predictions, the most critical startpoint for heap leach characterization is the construction process itself. Then it ventures into the bedrock of heap leach construction, analyzing the modeling techniques that capture their physical formation: layer by layer, lift by lift, circuit by circuit. Through industrial case studies and modeling comparisons, this work calls for a return to first principles to model the heap not as a black box for algorithmic speculation, but as a constructed, time-evolving system.

10:05 am

Unrecovered Metal in Spent Ore of Heap Leaches

K. Farrell, A. Young and P. Rogers; University of Utah, Salt Lake City, UT

This paper will discuss the residual value of what the mining industry has called spent ore for decades. Based on conducted research the true term should be unrecovered metal. What was previously deemed as spent ore has been revitalized by advancements in technology. The unrealized value of this unrecovered metal, either by improper pile management, environmental challenges or downturn in metal prices could see impactful changes in recovering this metal partnering with emerging technologies especially at current spot metal prices. The collective amount of spent ore heap leach operations worldwide could see old mines reopened to retrieve what was left behind with minimal disturbances. While improving current operations life of mines and metal recoveries. The paper will look at a finite number of operations for what unrecovered metal potentially exists, with simple benchmarking techniques it would be applicable to other operations that have existing spent ore heap leaches.

10:25 am

26-031

A Review of the Design Guidance for Heap Leach Facilities Following Recent Mass Movements, Particularly Discussing the Applicability of Dam Safety Guides and Standards to Potentially Flowable Heap Leach Masses

A. James; NewFields Canada Inc., Saskatoon, SK, Canada

Recent catastrophic failures of heap leach facilities worldwide have highlighted critical gaps in design guidance and regulatory frameworks. This paper examines the applicability of existing dam safety standards to heap leach operations, particularly when ore masses exhibit flowable characteristics under saturated conditions. Current heap leach design relies primarily on earthworks and slope stability principles, recent incidents in saturated heap materials exhibit liquefaction potential and rapid mass movement, similar to tailings. Do current design standards inadequately address the unique challenges of heap leach facilities: variable material properties throughout the heap lifecycle, complex geochemical interactions affecting shear strength, and the potential for rapid strength loss under changing moisture conditions. Dam safety guidelines, while comprehensive for water retention structures, require significant adaptation for heap-specific failure modes. This paper suggests hybrid design approaches incorporating both earthworks and dam safety principles, enhanced monitoring protocols, and revised factor-of-safety criteria.

10:45 am

26-003

A Method to Assess the Feasibility of Injection Leaching on Heap Leach Slopes

M. Alam, S. Tripathi and J. Scheremeta; Knight Piesold and Co., Denver, CO

Injection leaching improves ore recovery by displacing retained solutions, enhancing ore wetting, and creating new flow paths for efficient solution collection. This paper presents a method to assess the feasibility of injection leaching (from a geotechnical slope stability perspective) using limit-equilibrium (LE) slope stability analysis and static deformation modeling. LE models were carried out by assigning peak undrained strength to the heap leach ore material, and modeling the excess pore pressure induced during the injection leaching process using spatial function in Slope/W. Static deformation modeling was completed using the software Fast Lagrangian Analysis of Continua (FLAC) to evaluate the deformations due to the excess pore pressures induced during injection leaching process. A constitutive model was used to represent the geomechanical behavior of the leached ore material, which enables the prediction of deformation and potential stability issues resulting from excess pore-pressure induced during injection leaching process. The two-pronged approach provides a practical method to assess geotechnical impacts and guide data-driven decisions in injection leaching operations.

11:05 am

Panel Discussion After Presentations (if time allows)

Tuesday, February 24 Afternoon

BEST OF SME MARINE MINERALS- OFFSHORE TECHNOLOGY CONFERENCE SHOWCASE

250B

Chairs: ***C. Wyatt****, Atlantic Strategic Minerals*
K. Stoll*, Atlantic Strategic Minerals*
G. Beckstrom*, SME Foundation Board of Trustees, Minneapolis, MN*

2:00 pm

Introductions

2:05 pm

26-049

Prospects for Marine Minerals in the US Pacific OCS and EEZ

D. McConnell; Geomarine Resources, Houston, TX

The seafloor in the US Pacific OCS and EEZ is enriched to varying degrees in critical and economically important minerals such as nickel, manganese, cobalt, copper, zinc, REY (rare earth elements plus yttrium), titanium, vanadium, antimony, gold, and silver. These mineral deposits take the form of polymetallic nodules on the seabed, cobalt rich ferromanganese crusts on seamounts and ridges swept clean of sediment accumulation, and seafloor massive sulfides formed by hydrothermal systems at geologic plate spreading centers and volcanic margins. Commercial interest in deep sea mineral deposits and the potential for collecting or mining them began in earnest in the 1970s but has been heightened in the last 20 years as regulatory regimes have matured and demand for minerals to supply energy and manufacturing has increased. Key compilations were made by the Circum-Pacific Council and USGS, historical data maintained by NOAA, and recent publicly disclosed results from ISA contractors are used to inform the known occurrence and prospectivity for polymetallic nodules, cobalt-rich ferromanganese crusts, and seafloor massive sulfides in the US Pacific OCS and EEZ.

2:25 pm

26-017

Critical and Hard Offshore Minerals Resource Management on the United States Outer Continental Shelf

P. Knorr; Bureau of Ocean Energy Management, Sterling, VA

The Bureau of Ocean Energy Management (BOEM), a bureau within the U.S. Department of the Interior, has responsibility over both energy and non-energy mineral development on the United States Outer Continental Shelf (OCS) under the OCS Lands Act ("OCSLA"). BOEM's Marine Minerals Program (MMP) manages federal offshore mineral deposits, including non-competitive agreements for federal sand and gravel ("sand") used in coastal restoration efforts and the competitive leasing of critical and hard economic minerals ("critical minerals"). As the federal steward of OCS critical and hard minerals, BOEM MMP is responsible for locating critical minerals, identifying and understanding their environments, managing activities that affect these resources, and implementing pertinent federal policies. Four federal rules in the Code of Federal Regulations (CFR) currently inform MMP's procedures: 30 CFR 580 (prospecting for minerals), 30 CFR 581 (leasing of minerals), 30 CFR 582 (operations in the OCS related to minerals), and 30 CFR 583 (negotiated noncompetitive agreements for sand). Other federal laws and regulations are also pertinent, including the National Environmental Policy Act.

2:45 pm

26-012

Challenges in Massive Sulfide Deposit Exploration Using a Seabed Drill Rig for Mineral Core Sampling

S. Wegerer and M. Semel; Bauer Maschinen, Schrobenhausen, Germany

The search for minerals typically starts with a reconnaissance phase. After finding a promising target area, further prospecting work will be conducted. Finally with growing confidence of having encountered an ore deposit with commercially viable concentrations of relevant minerals, an extensive exploration campaign will verify its potential. Best practice and reliable, efficient tools for mineral resource estimation of massive sulfide deposits in the deep sea have to be established yet. Therefore, a new seabed exploration system is in development. Various challenges are caused by the extreme environmental conditions in the deep sea and by the nature of massive sulfide deposits. Information of past and ongoing expeditions were gathered to form the basis of an in-depth requirement analysis. System functions and corresponding process times were derived. The experience from the existing MeBo seabed drill rigs serve as starting point for the concept study and following development. Initial MeBo system was built for maritime research purposes and now has to be converted into a new design, suitable for efficient and economic resource exploration.

3:05 pm

Considerations With Respect to the Technology and Economics of Nodule Offloading from a Deep-Sea Nodule Production Vessel to a Transport Vessel in the Open Ocean, and Transportation to a Port for Offloading:

J. Wodehouse[1] and J. Halkyard[2]; [1]International Marine Minerals Society, Belfast, ME and [2]Society of Naval Architects & Marine Engineers, Houston, TX

Abstract: Since the first development and testing of technology for the collection of polymetallic nodules in the ultra- deep ocean (>4,000 m water depth) in the 1970's, there has been over 40 years of technology development and successful operations by the offshore oil and gas, and bulk material shipping industries. This article addresses specifically the challenges associated with handling and offloading the nodules from a Production Vessel to a Transport Vessel on a regular basis in the open ocean, describing where current industry practice could be applied to resolve those challenges, identifying the unique aspects of the offloading operation and the sensitivity of the overall project costs to differences in the Offloading System design. The study identified a strong possibility of utilizing bulk carriers as the Transport Vessel moored in a tandem mooring arrangement without the requirement for Dynamic Positioning.

3:25 pm

26-016

Could One Size Fit Most? A "Right Sized" Vessel For Deep Sea Minerals Exploration In Remote Regions

H. Smit, L. Meyer and G. van Eck; Moana Minerals Inc, Hamilton, VA

This paper describes the specification, design and integration of a purpose-built exploration vessel for deep sea minerals research, right sized and optimized for operations in the nodule fields of the Cook Islands at depths of up to 6000m. We walk through the requirements analysis, vessel selection, reactivation and modification, sampling equipment selection, deployment/recovery systems and optimized overall operational layout within a smaller vessel footprint than traditionally employed for this type of work. Finally, we provide examples of results from multiple research and exploration campaigns and discuss how the selection of a right-sized/right features vessel as a clean slate for conversion set us up for success and gives the Anuanua Moana advantages over other vessels.

3:45 pm

26-048

Polymetallic Nodule Detection Using Hull-mounted 30 Kilohertz Multibeam Data Analysis

M. Mussett[1], M. Kaufmann[2], T. Conrad[2] and D. Naar[1]; [1]University of South Florida, St Petersburg, FL and [2]Odyssey Marine Exploration, Tampa, FL

Benthic habitats of the Pacific Ocean consist of different geologic domains consisting of sedimented abyssal hills, high relief features such as seamounts, and polymetallic nodule fields. Nodules provide habitat, and are of economic interest due to metals content. Multibeam data can be used to classify seafloor geology. Our research examines how incorporating analyses of multibeam backscatter and bathymetry, regional environmental parameters, and GIS analysis can identify polymetallic nodule fields. We developed a workflow for processing multibeam data within QPS software, and a GIS protocol for evaluating processed multibeam outputs. These methods were tested with publicly available multibeam data. Multibeam products were used to identify areas of coarse sediment backscatter and low relief; filters for water depth, seafloor age, and sedimentation rate were applied. GIS cluster analysis further identified trends within the data to forecast where nodules may exist. This analysis can identify unexplored nodule fields, edify estimates of global nodule extent, and support ecosystems modelling, marine spatial planning, and mineral resource management.

Tuesday, February 24 Afternoon

BULK MATERIAL HANDLING: CONVEYOR OPTIMIZATION

155A

*Chair: **E. Michiels**, Mineral Processing Partners, Lithia, FL*

2:00 pm

Introductions

2:05 pm

Haul More with Gearless: Transitioning from Conventional to Gearless Conveyor Drives at LKAB Malmberget

U. Richter; ABB AG, Cottbus, Germany

As part of its ongoing commitment to operational excellence and sustainability, LKAB is undertaking a major upgrade of its conveyor system at the Malmberget iron ore mine in northern Sweden. This initiative involves replacing conventional conveyor drives on a more than 20-year-old system by ABB Gearless Conveyor Drives (GCDs), marking a strategic shift toward more efficient and reliable material handling as well as increased production. This paper focuses on the challenges and strategies involved in designing and implementing two 1,600 kW GCDs equipped with permanent magnet motors (PMMs), which will replace an aging 2,800 kW wound rotor induction motor and gearbox system. The logistics of transporting and assembling the large drive units in confined underground spaces required meticulous planning. The gearless design not only reduces spatial requirements but also significantly lowers the fire load and audible noise, contributing to a safer working environment. The achievements of the first 3 months in operation will be finally concluded.

2:25 pm

26-021

Design and Implementation of Belt Conveyor Take-Up Safety Device Systems

C. Stephenson[1] and M. du Preez[2]; [1]UCT, Kommetjie, Western Cape, South Africa and [2]Ontario Institute of Technology, Oshawa, ON, Canada

Overland belt conveyors often use vertically guided counterweight take-ups or horizontally tensioned carriages to maintain belt tension. In the event of belt or wire rope failure, these systems can release significant stored energy, creating high-impact forces that risk structural damage and personnel injury. This paper reviews current safety arresting technologies and presents a calculation methodology for estimating impact velocity, energy absorption requirements, and stroke limitations. Worked examples illustrate the selection process for appropriate arrestor types under different design constraints. The study emphasizes early integration of safety devices to minimize structural loads, avoid costly retrofits, and enhance operational reliability. Implementing robust arrestor systems improves safety and reduces downtime in bulk material handling environments.

2:45 pm

30 Years of Conveyor System Simulation and Analysis

P. Ormsbee; Overland Conveyor Company, Inc., Lakewood, CO

Overland Conveyor Company's 30th anniversary year is 2026. This presentation will be a historical review of major analysis and simulation techniques that have enabled innovation in conveyor systems since 1996. The bedrock of any quality conveyor system design is the simulation and analysis of the conveyor prior to the system being built and tested. Conveyors are somewhat unique in the fact that system prototyping is not a cost effective way to ensure system performance is achieved. Because of this, major innovations within conveyor systems including improvements to efficiency, the introduction of horizontal curves, dynamic analysis, application of remote drive controls, and system monitoring has been driven by the industry's use of computers and simulation. The presentation will discuss how published methods and standards have changed over the years (power and friction calculations within CEMA 5th, 6th, and 7th methods), how simulations have enabled specific innovations, and where the latest developments in simulation are going.

3:05 pm

Optimizing Hauling Efficiency: A Comparative Analysis of Tipper and Articulated Dump Trucks

L. Madziwa; Namibia University of Science and Technology, Windhoek, Namibia

This research addresses inefficiencies in surface mine hauling operations caused by diverse equipment and high hauling cycle times. It observed that actual hauling cycle times exceeded theoretical benchmarks by 22% for direct tipping into the primary crusher and 17% for tipping -60mm ore into a secondary screen, leading to reduced truck productivity and increased diesel consumption. Given that hauling accounts for 45% of surface mining expenses, the study used the Analytic Hierarchy Process (AHP) to evaluate the efficiency of Tipper and Articulated Dump Trucks (ADTs) based on cycle times, productivity, and fuel consumption. The AHP analysis concluded that ADTs are the superior option, scoring 0.86 compared to 0.14 for Tipper Trucks, primarily due to their higher payload capacity and operational efficiency. Sensitivity analysis further showed that reducing tipping times could increase production rates by 17% for +60mm ore and 23% for -60mm ore when using ADTs. The key recommendations include prioritizing ADTs for ore hauling and allocating more resources to optimize the hauling process.

3:45 pm

Comparing Innovative Ore Haulage Systems: Performance, Cost, Decarbonization, and Ventilation

B. Babcock; Nordmin Engineering, South Jordan, UT

This presentation provides a comparative analysis of emerging ore haulage technologies, evaluating operational performance, capital and lifecycle costs, and impacts on decarbonization and mine ventilation requirements. Systems reviewed include trolley-assist trucks, autonomous battery-electric haul trucks, in-pit crushing and conveying (IPCC), and hybrid rail/hoisting solutions. The session highlights key selection criteria such as orebody geometry, haul distance, grade profile, and energy infrastructure. Case studies from operating mines illustrate trade-offs in productivity, emissions, and maintenance. Attendees will gain insight into selecting haulage innovations that align with site-specific conditions to improve sustainability, reduce ventilation loads, and lower total cost of ownership.

4:05 pm

Mining's Ubiquitous Dust Issues: How Can Your Site Keep Workers Safe, Including Complying with New MSHA Silica Dust Exposure Limits?

D. Johnson, K. Trapani and M. Guerrero Pena; Stantec, Phoenix, AZ

Material handling dust typically falls into 3 categories: > Hazardous – sources include heavy metals, asbestos, and toxic materials; can cause breathing issues, skin problems, and long-term health problems > Respirable Crystalline Silica – affecting work that deals with materials like quartz, granite or sand, silica dust is linked to serious conditions, including silicosis, lung cancer, and other lung diseases > Combustible – Sites handling coal, wood, some metals, or certain chemicals can produce very small bits of dust that can catch fire if floating in the air Which of these do you think is the most dangerous? It depends on the context. What's important is to manage dust from sources when possible, as well as ensure levels are maintained within allowable limits based on site based, regulatory and/or international standards. This session will help you understand: > How to identify and monitor hazards > How to maintain sites to comply with MSHA & OSHA regs > What is the status of the new MSHA Silica Rule and how will that affect your operations > New solutions, and better ways to utilize old ones, to manage operations to keep your teams safe with limited disruption.

Tuesday, February 24 Afternoon

COAL & ENERGY: GENERATING REVENUE FROM METHANE MANAGEMENT & ALTERNATIVE ENERGY

151G

Chairs: ***M. Karmis****, Virginia Tech, Blacksburg, VA*
J. Fidler*, Core Resources, Canonsburg, PA*

2:00 pm

Introductions

2:05 pm

Understanding Methane Emissions from Underground Coal Mines in Colombia as a First Step in Developing Strategies for Reuse

S. Escudero[1], K. Smits[1] and O. Restrepo Baena[2]; [1]Southern Methodist University, Dallas, TX and [2]Universidad Nacional de Colombia, Medellin, Antioquia, Colombia

Methane emissions from underground coal mining pose serious safety and operational risks, making monitoring essential. However, direct measurements are often unavailable—particularly in emerging economies. In a series of field experiments at medium scale coal mines in Colombia, for the first time, we continuously measured methane emissions using unique point source sensors dispersed throughout the mine. These low-cost sensors offer an economical alternative for small-scale operations with limited resources. Results demonstrate that emission rates varied spatially and temporally and Some values fall within the range of catalytic oxidation systems, presenting an opportunity to reuse methane as an energy source.

2:25 pm

A Modular Catalytic System for Low Concentratoin Methane Mitigation

H. Hawa, T. LaBreche and S. Roychoudhury; Precision Combustion, Inc., North Haven, CT

Precision Combustion, Inc. (PCI) has developed a modular catalytic system for mitigation of ventilation air methane (VAM) from underground coal mines. A 1,000 SCFM pilot unit was designed, fabricated, commissioned, and is now being tested at a mine site. Preliminary performance data showed >99% methane destruction and removal efficiency (DRE) at <500°C. PCI's catalytic oxidation technology is based on an advanced contaminant-tolerant catalyst and compact design that enables high methane DRE at lower operating temperature. Catalyst durability and contaminant tolerance were demonstrated for >1,000 hours for destruction of low methane concentrations (<0.2%) from high volumetric flow streams. Levelized cost of carbon abatement (LCCA) shows potential for added revenue via carbon credits. Performance data from field test unit operation and life cycle impact findings for methane mitigation from mining operations will be discussed.

2:45 pm

New Challenges for Subsurface Spatial Planning and Engineering of Underground Space in Germany

M. Gurgel and A. Preusse; RWTH Aachen University, Aachen, North Rhine-Westphalia, Germany

In the context of Germany's and Europe's energy transition and rising global demand for decarbonized infrastructure, the geological subsurface is gaining new strategic relevance – not only as source of resources but also as a space for energy and storage infrastructure. This contribution presents new approaches for managing underground space as a shared and limited resource that build on conventional surveying techniques, advanced technologies for acquisition and management of geodata and the demands for a resilient energy and resource supply. Methods such as Structure-from-Motion photogrammetry, LiDAR and 3D geospatial modelling are used to create transparent, high-resolution underground models that support project approval procedures and long-term monitoring. This approach transfers decades of expertise in mining subsidence engineering and monitoring of mining activities and their effects to the surface to future tasks such as deep geothermal energy and underground storage of energy and commodities. Examples from ongoing research demonstrate how a holistic geodata basis can help to overcome conflicting interests for strategic and socially accepted underground utilization.

3:05 pm

VAMOX® Full Scale RTO Technology For The Abatement of VAM Emissions

J. D'Amours-Cyr, D. Kay and G. Drouin; Biothermica Technologies, Montreal, QC, Canada

Ventilation Air Methane (VAM) from underground coal mines, contributing to ~65% of global coal mine methane (CMM) emissions, has long posed challenges for mitigation due to its low and variable methane concentrations (0.1–1.5%). While higher-concentration CMM has been harnessed for power generation, VAM abatement has encountered challenges including technical constraints, safety concerns, and insufficient economic incentives. This case study highlights Biothermica's expertise in VAM abatement through its VAMOX® regenerative thermal oxidation technology. After successfully operating a demonstration unit in Alabama (2009–2013), two full-scale VAMOX® systems with capacities of 150k and 190k acfm were deployed in Virginia in 2022 and 2024, respectively, currently abating a combined ~500,000 tCO2e annually. Biothermica's ongoing research now focuses on the integration of catalysts to enable efficient oxidation at methane concentrations as low as 0.15%, while at higher concentrations, the emphasis shifts on recovering and valorizing waste heat to improve system efficiency and economic viability.

3:25 pm

Catalytic Oxidation of Trace Methane Sources Found in Ventilation Air Methane (VAM)

H. Chen[3], C. Dischner[1], P. Evans[1], J. Fidler[2], P. Flynn[2], J. Fedeyko[1], M. Karmis[4], Y. Lugo-Jose[1], A. Palermo[1] and D. Watson[1]; [1]Johnson Matthey, Wayne, TX; [2]Core Natural Resources, Canonsburg, PA; [3]Oak Ridge National Lab, Oak Ridge, TN and [4]Virginia Tech, Blacksburg, VA

The DOE funded REMEDY project (DE-AR0001532), Johnson Matthey, Oak Ridge National Laboratory and Core Natural Resources (CNR) have oxidized trace sources of methane at concentrations lower than 0.1%v/v. The Catalytic Oxidation of Methane (COMET™) technology is validated by the continuous operation of a field test unit (FTU) located outside of a bleeder shaft on CNR's site. The FTU successfully abates methane, by catalytically converting it to carbon dioxide, in a range of 0.1-1.2%v/v at a destructive performance >99.5%. Heat is recovered through the oxidative reaction by a recuperator at an efficiency >90% and runs self-sufficiently. COMET™ is critical to being able to treat VAM from active coal mines as low concentration VAM accounts for 70% of the emissions. This is estimated to be ~26million carbon credits per year in the US (assuming a GWP of 21x CO2). Also discussed is proof of methane abatement in line with the California air Resources Board Protocol of April 2014. An updated modular commercial design will also be presented and discussed alongside the CO2e Levelized Cost of Carbon Abatement (LCCA) for the system.

3:45 pm

Maximizing Value of Waste Methane Emissions

B. Apple; Environmental Commodities Corporation, Boulder, CO

Carbon Credits, Alternative Energy Credits, Renewable Natural Gas Credits, Methane Offset Credits, Tax Credits… Do these incentives still exist and are any sufficient to enable voluntary destruction of mine methane emissions? This presentation is primarily a cost-benefit analysis of mine methane destruction technologies. All current and near-term technologies will be evaluated based on safety, technical feasibility, and revenue potential. Implications of state, federal, and international regulatory schemes will be examined and discussed. The dominate financial incentive for mine methane mitigation in the U.S. has historically been the California Cap-and-Trade Program. The downward trend of California Carbon Offset prices will be examined based on the domestic economy and market speculators. Opportunities created by voluntary climate change programs will be considered as potential alternative sources of revenue. Questions, comments, and critiques are welcome to make this an interactive and challenging presentation.

4:05 pm

Allied Forces of Soda Ash & Lithium in Battery Production

J. Bronstein; Ghost Solutions LLC, Rock Springs, WY

This presentation focuses on the allied relationship between Soda Ash and Lithium in Battery Production. Lithium is critical for Lithium-Ion Batteries, being a component of the cathode and electrolyte. Sources include brines and pegmatite minerals. Extraction processes from ore and brines are detailed, encompassing steps like crushing, chemical conversion, purification, and crystallization to produce Lithium Carbonate or Lithium Hydroxide. A significant amount of Soda Ash is consumed in lithium carbonate production, its usage varying with impurities and process efficiencies. "Not So Fun Facts" highlight considerable water requirements for lithium carbonate plants, the need for large pond complexes, and Li-depleted brine re-injection systems. Political considerations also emerge, as many states lack pre-existing regulations or royalty rates for lithium production. The growing global demand for lithium, driven by automotive and energy storage batteries, consequently increases the demand for soda ash. The presentation also touches on minimum economic plant sizes for both Lithium Carbonate and Soda Ash production.

Tuesday, February 24
Afternoon

COAL & ENERGY: RESEARCH & DEVELOPMENT

Sponsored by BARR

151 A-C

Chairs: ***S. Schafrik****, University of Kentucky, Lexington, KY*
M. Trevits*, Xtraction Science and Technology, Inc, Pittsburgh, PA*

2:00 pm

Introductions

2:05 pm

Uniaxial Displacement of Soil Specimen, Kaolinite Clay, Under Stress Concentration Using Digital Image Processing and Numerical Modelling

R. Bentil; New Mexico Institute of Mining and Technology, Socorro, NM

Understanding soil deformation under localized loading is essential for assessing the stability of foundations, underground excavations, and earth structures. This study explores the uniaxial displacement behavior of Kaolinite clay under stress concentration through a combined experimental and numerical approach. Remolded clay specimens with engineered geometries were subjected to uniaxial compression to induce controlled stress concentrations. Displacement fields were captured using digital image correlation (DIC) techniques in Mathematica and MATLAB, enabling precise, non-contact measurements of surface deformation and strain localization. Simultaneously, a finite element model of the test setup was developed in NISA software to simulate stress–strain responses under identical conditions. The model was calibrated and validated using experimental results to ensure accuracy in capturing both global and localized responses. The study seeks to correlate displacement patterns with stress fields, focusing on the initiation and propagation of strain localization zones.

2:25 pm

A New Blast Efficiency Index for the Assessment of Blast Performance in Mine-to-Mill Studies

R. Yang; Orica USA Inc, Watkins, CO

Explosive blasting is a widely utilized method for rock breaking, recognized for its energy efficiency and cost-effectiveness. This study quantitatively evaluates the energy efficiency of rock breakage by blasting, with a focus on powder factors, rock fragmentation size distribution, and the strength reduction of blasted rock fragments. A novel blast efficiency index is introduced to assess the energy efficiency of blasts in generating new rock fragment surfaces and reducing fragment strength through microfracture generation. Several examples were presented on the calculation of the blast efficiency index using the data from the literature. It indicates that blasting is most efficient way of breaking the rock. It also indicates that great potential exists to increase the blasting efficiency of using explosive energy during the blasting. The proposed blast efficiency index can be used with advanced blast modeling to optimize blast designs. Each design scenario can be modeled for fragmentation and microfracture strength reduction. An improved blast design can be selected based on a higher blast efficiency index, benefiting downstream mining operations while controlling blast costs.

2:45 pm

Signal-Based Analysis for Monitoring Pick Cutter Wear in Rock Cutting Applications

A. Morshedlou and J. Rostami; Colorado School of Mines, Arvada, CO

Monitoring the condition of cutting tools in real time is crucial for improving operational efficiency and reducing downtime in excavation systems. This study investigates the use of cutting force signals obtained from linear cutting machine (LCM) experiments to classify pick cutter wear conditions and identify rock types through signal-based analysis. Various rock samples, including coal, sandstone, limestone, and siltstone-mudstone composites, were tested under controlled cutting conditions using picks at three wear stages (new, moderately worn, and worn). The force signals were analyzed in both time and frequency domains to extract statistical features reflecting tool-rock interaction behavior. Results show that cutter wear significantly influences signal variability, peak values, and energy concentration across frequency bands. The findings support the development of automated condition monitoring systems by demonstrating a reliable correlation between signal patterns and wear levels. This approach offers promising potential for smart excavation systems in mining and tunneling applications.

3:05 pm

Evaluating Pressure Decay and Reflection in Sealed Underground Mine Tunnels Using Scaled Blast Simulations

R. Bauer and C. Johnson; Missouri University of Science and Technology, Rolla, MO

Post-blast pressure in sealed underground tunnels is a key factor in assessing risks to bulkhead doors and evaluating designs for new mine safety systems. This study used a 1/100 scale model of the Lake Lynn Experimental Mine in Ansys Autodyn to simulate explosive detonations and evaluate internal pressure decay when tunnel portals are closed. In the Lake Lynn geometry, pressures at the far end of the tunnel had decayed to negligible levels, suggesting minimal hazard for sealing systems. To assess worst-case scenarios, simulations with larger explosives and shorter tunnels were performed. These showed increased reflections and longer total pressure durations.

3:25 pm

MINESAFE: Mining Incident Narratives Extraction & Safety Analysis Framework for Coal Mine Accident Reports in India through Generative AI

S. Agarwal[2], R. Ganguli[1], I. Verma[3] and A. Jain[4]; [1]Professor of Mining Engineering, Salt Lake City, UT; [2]IIT (ISM), Dhanbad, India; [3]Manipal University, Jaipur, India and [4]Vivekananda Institute of Professional Studies, Delhi, India

Generative AI based technology is being developed to gain insights about coal mine accidents in India. Trained on textual data from India's Directorate General of Mines Safety, the development uses a novel approach that integrates Natural Language Processing and Retrieval-Augmented Generation to structure, cluster, and query coal mine accident reports spanning 2016 to 2022. Using various techniques, hundreds of reports based on causative factors such as ground control failures, transport incidents, electrical faults, and gas or dust explosions were categorized. Further, a hybrid RAG system capable of understanding user queries and retrieving relevant accident descriptions, inspector recommendations, and applicable regulatory clauses, significantly reducing human effort in root cause analysis and compliance checks was developed. A custom-built GUI was developed to enable intuitive interaction with this system. Evaluations by domain experts show promising accuracy and relevance in both retrieval and generative components, demonstrating AI-powered tools can augment regulatory intelligence and safety interventions in mining, particularly in resource-constrained settings.

3:45 pm

XR-Enabled Adaptive Feedback Loops for Human-in-the-Loop Control in Mining Operations

A. Barenji; New Mexico Institute of Mining and Technology, Socorro, NM

This work introduces an XR-enabled human-in-the-loop control platform designed to improve Human Autonomy Collaboration (HAC) in mining and industrial training scenarios through dynamic, feedback-rich interaction. The system fuses real-time biometric signals from the operator, as well as visual and sensor data from autonomous systems, with AI-driven agents that assess cognitive state and modulate how feedback is presented. Rather than relying on static alerts, the XR interface adapts the timing, modality, and complexity of visual, auditory, and haptic cues to optimize information delivery based on operator readiness and situational urgency. A digital twin of a mine emergency scenario validates the platform's ability to reduce cognitive overload, enhance situational awareness, and improve trust calibration. This closed-loop system keeps the human operator at the center of critical decision-making while enhancing responsiveness and communication from autonomous assets advancing safety, and operational resilience in high-risk environments.

4:05 pm

Experimental Investigation of Hydrogen Storage and Flow Behaviour in Coal Seams

J. Kwaw and L. Fan; University of Alaska, Fairbanks, Fairbanks, AK

Hydrogen is gaining attention as a clean energy source in the push for net-zero CO_2 emissions, especially in the U.S. Reliable year-round storage is crucial, with geological formations like coal seams offering potential, though understudied. This research explores hydrogen sorption and flow behavior in Anthracite, Bituminous, and Sub-Bituminous coals. Sorption data fit the Langmuir model for Anthracite and Bituminous, and the Freundlich model for Sub-Bituminous. Among the three, Anthracite shows the highest hydrogen adsorption capacity, making it the most promising candidate for underground hydrogen storage in coal seams. Understanding these mechanisms is vital for safe and efficient energy storage.

Tuesday, February 24 Afternoon

COAL & ENERGY: ROOM AND PILLAR OPERATIONS & PROJECTS

151 D-F

Chairs: ***A. Patterson****, LCT Energy, LP, Latrobe, PA*
K. Pan*, Oak Grove*

2:00 pm

Introductions

2:05 pm

Review of Claystone Floor Impacts on Pillar Stability

H. Christensen and G. Hasenfus; Barr Engineering Co, Duluth, MN

The relationship between abandoned mine floor heave due to softened underclay material that may result in coal pillar rib failure is assessed via empirical study and finite difference numerical modeling. Numerically, the thickness and strength of the underclay materials are varied to determine failed depths of pillar rib, which may be used to estimate the change in effective pillar dimensions that could impact pillar stability. Empirically, stability factors from revised pillar geometries are compared to subsidence occurrences over abandoned coal mines, with an attempt to establish possible relationships between softened underclay thickness, pillar size reduction, and pillar failure.

2:25 pm

Outlook for the US Underground Coal Industry

W. Wolf; John T. Boyd Company, Canonsburg, PA

This paper will provide a forecast of coal production from US underground (i.e., longwall and room-and-pillar) operations for the 2025 to 2030 time-period. To provide a historical perspective, US coal production information for the previous four-year period (2021 to 2024) will be discussed. Production data will be provided by general mining method (i.e., surface and underground) and by location (state). For the same period, historical coal production data by active longwall and room-and-pillar mine operations will be provided. Longwall and room-and-pillar operating data will be organized by: 1) location (state) and 2) operating company/controlling entity. Projected US coal production data for the 2025 to 2030 period will be provided by mining method (i.e., surface and underground operations) and location (state). BOYD's estimate for future underground production by longwall and room-and-pillar mines will be provided. Forecasted production will be arranged by: 1) state location (for longwall and room-and-pillar operations) and 2) operating company/controlling entity (for longwall operations).

2:45 pm

The Tintina and Kaltage Faults and Associated Critical and Strategic Minerals in the Livenggod Quadrangle, Alaska

P. Metz; TBD, TBD, AK

The Tintina-Victoria-Kaltag Fault system forms a large arcuate structure that defines the plate boundary between the North American craton and the Yukon Tanana Terrane (YTT) and its included Tintina Gold Belt (TGB). The fault system extends from British Columbia throught the Yukon Territory to east-central Alaska and on to south-west Alaska The southern boundary of YTT and the TGB is the Denali-Farewell Fault system. The Livengood Quadragle forms the apex of the arc and the center of major gold momeralization in the TGB. Placer gold was discovered iin Livengood in 1913 and was the last gold rush in Alaska and Livenggo is problably the next critical & strategic mineral 'rush' in the State.

3:05 pm

Extra Tough Cemented Tungsten Carbide in Continuous Mining

T. Puzz; Kennametal, Inc., Rogers, AR

Kennametal's new extra tough carbide grade is the toughest mining grade developed in its expanding portfolio of wear resistance materials. It excels in hard rock cutting conditions and provides good resistance to thermal fatigue (heat checking) due to the microstructural design and extra coarse grain structure. Compared to the competition and our current carbide, the extra tough grade shows a reduction in the crack branching mechanism caused by thermal fatigue. This paper will present microstructural analysis, thermal, mechanical and wear testing data which shows the improvement in properties. The paper will also share successful field results in continuous mining drum testing to validate the lab data.

3:25 pm

The Implication of the Intermediate Principal Stress Component on the Plastic Zones and Safety of a Mine Pillar

D. Maina; TU Freiberg, Freiberg, Germany

Underground Mine failures pose major safety risks, threatening both personnel and equipment. Existing conventional rock engineering constitutive models neglect the influence of the intermediate principal stress component, leading to inaccurate stability assessments and suboptimal mine designs. In this study, a novel three-dimensional (3D) elasto-plastic constitutive model, referred to as the Extended Hoek-Brown (EHB) model is implemented within the FLAC^{3D} numerical framework. It captures the complex mechanical behavior of rock under varying stress conditions by incorporating the intermediate principal stress component. A corresponding strength reduction technique is proposed to improve the determination of the factor of safety for mine pillar. Numerical simulations conducted on mine pillar demonstrate that the EHB model significantly reduces the extent of plastic zones and enhances the factor of safety compared to the classical HB model. These findings highlight the critical role of the EHB model in accurately assessing stability, optimizing pillar design, and ensuring the safety and reliability of underground rock structures.

3:45 pm

Henderson County Mine Development – Part 2

B. Mackellar, L. Griggs and D. Brockman; River View Coal. LLC, Waverly, KY

The Henderson County Mine development project located in west Kentucky commenced in 2022. Details of this project including rehabilitation of an abandoned slope, mining a "corridor" through the west Kentucky #11 seam, and mining three approximate 1000' slopes down to the west Kentucky #9 seam, were outlined at the 2025 SME Mine exchange annual conference. This presentation forms Part 2 of the development project and details the construction of the Portal facility, shaft development, and sequencing of the startup of mining production units.

4:05 pm

Recent Ground Control Challenges at Low Seam Western Pennsylvania Underground Coal Mines

S. Baker; Rosebud Mining, State College, PA

Underground coal mining presents many ground control challenges across the country and world. These issues pose challenges to safety and productivity, and are often amplified in low seam underground mines given the restrictions imposed by opening heights as low as 36" and the equipment required to operate in them. This presentation will discuss several recent ground control issues and how they were adressed in Rosebud Mining Company's mines.

Tuesday, February 24
Afternoon

EDUCATION: EDUCATION AND OUTREACH - K-12 AND BEYOND

150D-E

Chairs: ***A. Brickey****, South Dakota School of Mines and Technology, Rapid City, SD*
A. McBrayer*, West Virginia University, Morgantown, WV*

2:00 pm

Introductions

2:05 pm

MINING ROCKS! Penn State Mining Summer Camp

B. Arnold and A. Kumar; The Pennsylvania State University, University Park, PA

How do you get high school students to consider a career in the mining industry? We believe you need to show them that minerals are important, mining and processing of those minerals are even more important, and that they can be a part of this vibrant industry. With alumni, industry, and mining-related organization support, we conducted free-of-charge mining camps the past two summers. When a camper asks if they can stay a "couple more days," we think we did something right! We'll discuss the nuts and bolts of summer camp, lessons learned, and room for continuous improvement.

2:25 pm

Changing the Narrative: From No Mining to Know Mining – A New Mining Awareness and Education Tool

M. Lee; Westward, Boerne, TX

The No Mining, Know Mining effort was designed to promote awareness, education and understanding about the benefits, and absolute necessity, of mining. Mining is Life Saving, Life Changing and Life Sustaining. The shift toward greener energy demands a broader spectrum of minerals than ever before. Everything from your health to national security relies on the availability of a wide variety of minerals. Even our nation's infrastructure relies immensely on concrete and asphalt aggregate products. This website illustrates the essential role of minerals and why they matter. As well as providing information for seasoned professionals.

2:45 pm

Adapting Extended Reality (XR) Applications for Minerals Industry Recruitment and Retention

A. McBrayer and D. Tuncay; West Virginia University, Morgantown, WV

Generations Z and Alpha have limited exposure to the opportunities in the minerals industry and the career paths available. West Virginia University's (WVU) Department of Mining Engineering has adapted existing extended reality applications such as VR-MRT to attract the next generation of Mining Engineers. This project demonstrates the successful utilization of virtual environments across K-12 and post-secondary age groups to increase student awareness. Herein, we examine the challenges of utilizing extended reality for recruitment and outreach and describe the successful integration of this medium in middle school, high school, and early post-secondary outreach at WVU.

3:05 pm

Advancing Mining Education Through an AI Powered Virtual Lab

G. Pundhir; University of Arizona, Tucson, AZ

Our team at the University of Arizona School of Mining Engineering & Mineral Resources has developed an AI powered Virtual Lab Chat Agent integrated with interactive web based simulations to spark curiosity and hands on experience in K–12 students. Leveraging Retrieval Augmented Generation, the agent delivers real time guidance, contextual hints, and adaptive feedback across modules including Ore Formation, Metallurgical Processing, and 3D Environmental Reclamation. Story mode narratives invite young learners into realistic decision points, enhancing engagement and retention. In planned pilot studies, we will assess learning gains in conceptual understanding and skill mastery.

3:25 pm

Changing Minds in Mining: A Grassroots Model for Educator Outreach

C. Whitman; Texas Mining and Reclamation Association, Tyler, TX

In Texas, a unique grassroots model led by the Texas Mining and Reclamation Association is reshaping how educators and their communities perceive mining. For over 30 years, immersive workshops hosted at active mining operations have given teachers firsthand experience with modern practices in mining, reclamation, and materials processing. Participants hear directly from engineers, geologists, and safety professionals while exploring surface mines, quarries, power plants, and processing facilities. These experiences have sparked curriculum shifts, local advocacy, and even career pipeline connections for students. TMRA estimates that through these educators, the program has reached over two million students. This session explores how a long-standing, educator-centered initiative has successfully reframed mining as essential, ethical, and innovative. It also makes the case for replicating this model nationwide. With direct applications in aggregates, energy, and environmental outreach, this safety-focused and story-driven approach offers a novel, scalable solution to one of the industry's toughest challenges: public perception.

3:45 pm

Inspiring the Next Generation: Establishing and Managing Rio Tinto Kennecott's STEM Committee

S. Barcelona; Rio Tinto, South Jordan, UT

Formed in late 2023, the STEM Committee at Rio Tinto Kennecott aims to build a diverse pipeline of future mining talent through strategic outreach. With defined roles and leadership support, the committee coordinated 17 events in its first year, reaching over 18,000 students, parents, and educators. Activities included hands-on STEM demos, career talks, and mining history lessons. Efficient volunteer coordination and communication tools streamlined operations. Key lessons emphasized structure, shared responsibility, and creative engagement. Future plans include expanding offerings for older students and developing standardized "to-go" kits. This model offers a replicable framework for impactful STEM and workforce development.

4:05 pm

Cu at the Mine: Teacher Professional Learning Academy Improves Perceptions and Understandings of Mining and Mineral Resources

D. Moreno; University of Arizona, Tucson, AZ

Recent research reveals teachers, students, and parents hold challenging views of mining and lack a 21st-Century understanding of the state of the industry. Similarly, they are largely unaware of the ubiquity of minerals in our everyday lives and the science and technology involved with procuring them. The same research finds students trust their parents and teachers for almost all the information they believe to be true regarding career opportunities and educational pathways to access those opportunities. To take advantage of those relationships and improve the awareness and understanding of mining and mineral concepts in student populations, the University of Arizona School of Mining Engineering and Mineral Resources Education Outreach Program designed a summer professional learning academy for middle and high school STEM teachers. Through an engaging mix of classroom activities, speakers from industry and academia, and field trips to local mining and mineral-related sites, the program was able to increase teacher understanding of mining and mineral concepts and improve teacher perceptions of the mining industry, especially the career opportunities available to their students.

4:25 pm

Generative AI in Mining Engineering Graduate Education: Examining the Effects of ChatGPT on Cognitive Engagement, Critical Thinking, and Ethical Beliefs

N. Cunningham, R. Alhaj Bedar, S. Schafrik, A. Moradi, Z. Agioutantis and P. Roghanchi; University of Kentucky, Lexington, KY

As generative AI becomes further embedded in education, questions have arisen regarding its potential impact on students in their respective disciplines. This research aims to understand how ChatGPT can impact student cognition, specifically within mining engineering graduate education, an area where research on this topic is limited. Studies have indicated that the integration of generative AI in classrooms can have adverse effects on cognitive processes. Therefore, it is essential to focus on graduate education to understand the possible effects that may arise from students using ChatGPT. This study employed a pragmatic mixed-methods design to investigate the cognitive engagement and ethical beliefs of mining engineering graduate students while they used ChatGPT in three tasks. This research aims to explore how students utilize ChatGPT in this field and highlight how certain uses can impact different cognitive processes.

Tuesday, February 24
Afternoon

ENVIRONMENTAL: RECLAIMING THE PAST: STRATEGIES FOR MANAGING ABANDONED MINE LANDS

255A

Chairs: ***L. French****, WSP USA, Inc., Lander, WY*
A. Withers*, AECOM, Herriman, UT*

2:00 pm

Introductions

2:05 pm

Characterization and Evaluation of a Historical Mining Area: A Watershed-Based Assessment of the Tri-State Mining District (TSMD)

B. Holzbauer-Schweitzer, B. Schroth, D. Davis, P.G. and J. Bartos; Jacobs Engineering, Greenwood Village, CO

The TSMD is a former lead-zinc mining area within the Upper Spring and Lower Neosho/Spring River Watersheds, that encompasses portions of Kansas, Missouri, and Oklahoma. Environmental media (surface water, groundwater, soil, and biota) are impacted by elevated concentrations of Cd, Pb, and Zn. For several decades, various stakeholders have contributed to the collection of a vast amount of data throughout these watersheds. The purpose of this study was to compile the data collected from 2014 to 2023, evaluate the data's effectiveness in characterizing sources, and identify potential locations where interim and final measures could have the most influence.

2:25 pm

Geochemical Assessment of Critical Minerals in Mine Wastes in Central and Southern New Mexico

S. Nipah; New Meixco Institute of Mining and Technology, Socorro, NM

Legacy mining districts across New Mexico may contain untapped critical mineral resources in mine waste. This study investigates seven mining districts which host a variety of deposit types including sandstone-hosted copper, magmatic-hydrothermal replacement, copper vein, low-sulfidation epithermal Au-Ag, and carbonate-hosted replacement deposits. Geochemical analysis of mine waste samples reveals elevated concentrations of critical minerals, including bismuth (up to 120 ppm), tungsten (up to 200 ppm), vanadium (up to 340 ppm), zinc (up to 130,000 ppm) and copper (up to 49,500 ppm). Other associated minerals such as lead (up to 58,000 ppm) were also elevated. These findings highlight the potential for resource recovery of mine wastes and support national efforts to secure a resilient domestic supply of critical minerals through the reassessment of legacy mine waste.

2:45 pm

Sealing Abandoned Mine Land Openings: Ensuring Safety and Environmental Protection with High Tensile Wire Mesh

D. Wagner; Geobrugg North America, Portland, OR

Sealing abandoned mine land (AML) openings is crucial for public safety. Closure of shafts and adits improves the landscape, traditional methods include backfilling, rebar grates, or PUD. High-tensile steel wire mesh offers several benefits for sealing AML openings. Its durability and strength make it a long-term solution, capable of withstanding harsh conditions. The mesh's flexibility allows it to fit various sizes and shapes of mine openings, preventing unauthorized access. It is cost-effective, requires less maintenance, and is easy to install, making it a practical solution for both remote and non-remote locations. Furthermore, the mesh can be designed to meet bat-compatible closure requirements, ensuring the protection of habitats. Recent installations in Arizona, Utah, and New Mexico demonstrate the effectiveness of high-tensile steel wire mesh in mine closures. These studies highlight the mesh's ability to enhance safety, improve production performance, and provide long-lasting protection. AML clousers with high-tensile steel wire mesh is an effective and practical approach to ensuring public safety, protecting the environment, and preserving wildlife habitats.

3:05 pm

Licensing and Permittng a Mine Waste Remediation Technology

S. Cohen; DISA Technologies, Inc., Mills, WY

Mine waste remediation, especially uranium mine waste remediation, has traditionally been characterized as a mining operation under various state and Federal mining laws and as milling under the U.S. Nuclear Regulatory Commission regulations. However, these paradigms have significantly impeded the ability for private companies to treat mine waste, recycle the minerals, and stabilize the material that remains behind. Although the need for remediation appears obvious, the regulatory environment (even at the county level) does not provide an efficient method of approving mine waste remediation projects. However, progress is being made because of philosophical changes at the upper levels of the Federal Executive Branch that are paving the way for a future where mine waste remediation is seen as an obvious means of mine reclamation and not simply another mining activity.

3:25 pm

From Complexity to Clarity: Investigating and Selecting Passive Treatment at a Challenging Legacy Mine Site in Colorado

D. Heinze[1], S. Benjamin[2] and E. Paulson[3]; [1]Ramboll Americas Engineering Solutions, Inc., Denver, CO; [2]Boulder County Parks & Open Space, Longmont, CO and [3]Headwater Technologies, Eden Prairie, MN

The Cardinal Mill outside Nederland, Colorado dates back to the 1870s when processing of silver, gold, and tungsten ore began. Site investigations identified heavy metals impacts including discharge of impacted mine water to Barker Reservoir, a drinking water source for the City of Boulder. With the long mining history and intricate underground mine features, limited site access, adjacent residences, harsh winters, impacted water quality, historical site designation, and extensive permitting requirements, a thoughtful approach is needed to gather converging evidence to support a data-driven selection of a sustainable and cost-effective remediation strategy. Numerous and innovative investigative activities have included: a drone survey/LiDAR data collection, tracer study, geophysical study, flow/water quality monitoring, drilling into the mine adit, and bench-scale and field demonstration of a passive treatment option. A preliminary remedial alternative has been identified involving a natural reed-sedge peat product. Remedial design of the system has been initiated due to the extensive design and permitting process and deadline to meet discharge requirements with the State.

Tuesday, February 24 Afternoon

ENVIRONMENTAL: WATER RESOURCES MODELLING IN MINING

255D

Chairs: ***R. Valdes Pineda****, Piteau Associates, Tucson, AZ*
T. Fehan*, Piteau Associates*
C. Peters*, Montgomery & Associates, Tucson, AZ*

2:00 pm

Introductions

2:05 pm

Advanced Groundwater Modeling for Optimized Brine Mitigation in Potash Mining

A. Safi; Barr Engineering Co., San Luis Obispo, CA

Brine generation in potash solution mining poses risks to groundwater and surface water, requiring effective containment strategies. This study presents an advanced groundwater modeling framework for engineering brine containment systems, with a focus on water resource protection, cost optimization, and phased construction to support strategic capital planning. The framework includes a three-dimensional (3D) variable-density groundwater flow and solute transport model, integrated with a 3D stratigraphic model, to simulate brine migration and assess containment measures such as low-permeability cutoff walls, capture trenches, and pressure relief wells. Uncertainty analysis is incorporated to guide decisions under data limitations, while custom optimization tools refine system design and construction phasing, supporting strategic capital planning. We applied this framework at multiple potash mines, where modeling insights significantly improved containment system layouts, yielding projected cost savings in the millions while maintaining environmental protection.

2:25 pm

Environmental Impact Simulation Techniques for Open Pit Mining Operations: A Review of Modeling Approaches

A. Mead; GSI Environmental, Missoula, MT

Environmental impact assessment for open pit mining has evolved from simple empirical methods to sophisticated integrated simulation frameworks that address prediction uncertainty and operational risk. This review synthesizes current approaches for modeling cumulative environmental effects, including hydrological modeling, water quality prediction, climate change integration, and post-closure scenarios. Key techniques examined include groundwater flow modeling for dewatering assessment and coupled surface water models. Advanced simulations increasingly incorporate machine learning and uncertainty quantification methods for enhanced prediction accuracy. This synthesis provides mining engineers and environmental professionals with informed guidance for selecting modeling approaches based on site-specific conditions.

2:45 pm

Simulating the Subsurface Legacy: Hydromechanical Modelling for Safe and Sustainable Mine Closure

S. Dehkhoda, T. Chung and A. Flatten; Beck Engineering, Bowen Hills, QLD, Australia

As mines approach closure and dewatering stops, the rebound to natural groundwater levels introduces complex hydro-mechanical challenges. Such transition can span months to decades and may trigger hazards such as instability, subsidence, and seismicity due to increased pore pressure and hydrological loading. Understanding these processes is critical for a safe and sustainable post-closure transition. This paper presents a fully coupled, time-dependent hydro-mechanical model simulating water–rock interactions from pre-mining through closure. The mine-scale model includes key geological structures like faults and shear zones, and integrates boundary conditions such as rainfall, terrain, surface water, and mine drainage. It also accounts for mining-induced changes in rock conductivity and calculates strain energy release rates to identify zones of elevated seismic potential. By linking mining activities with long-term hydrogeological and geomechanical responses, the model supports risk assessment and informed closure planning. Its transient nature enables time-based analysis, supporting the design of stable, resilient post-mining landscapes that protect communities and ecosystems.

3:05 pm

Process Modeling as an Integral Part of the Design at the Lava Cap Mine Superfund Site Semi-Passive Treatment System

R. Thomas, A. Lewis, T. Wallis, S. Miyawaki, K. Nielsen, J. Ouverson, A. Berens, J. Greco III, A. Holla, G. Nguyen, I. Matagi, A. Sonawane, B. Schroth, J. Stefanoff, G. Hickman and K. Waltermire; Jacobs, Atlanta, GA

The final remedy for OU2 at the Lava Cap Mine is a semi-passive treatment system consisting of a ferric chloride addition system followed by three downstream passive treatment units: a primary settling basin, a surface flow wetland, and a horizontal flow limestone bed (HFLB) reactor. While conceptually the design was based on a sequential process aimed at specific treatment goals, sizing of each unit was driven by predictive modeling. PHREEQC was used to predict arsenic removal following ferric chloride addition. A computational fluid dynamics (CFD) model was developed to assist in designing the primary settling basin for iron solids removal. Field settling tests were conducted to calibrate the CFD model. First-order kinetic removal models (P-k-C*) were used to help size both the surface flow wetland and the HFLB reactor for arsenic and manganese removal. HEC-RAS and SPAW models were used to predict surface flow wetland velocities and hydroperiods. MODFLOW was used to predict short-circuiting within the HFLB. HEC-HMS was employed for hydrologic surface water runoff analysis. This presentation provides a summary of how these models were used to design the treatment system.

3:25 pm

Incorporating Water Storage and Reclamation into Mineral Asset Valuation Through Quantum Finance and Stochastic Risk Modeling

J. Moores; Aggregate Appraisals, Flagstaff, AZ

This study applies quantum finance and stochastic lattice modeling to value a high-quality basalt quarry in Northern Arizona, focusing on its transformation through post-mining reclamation into a utility-scale water storage and containment system. While Arizona law restricts severance of water rights without approval, the project leverages water storage economics under regulatory oversight to generate revenue. The valuation framework integrates aggregate production, reclamation costs, and complex water storage logistics with operational and regulatory risks. By utilizing Monte Carlo simulations and quantum risk modeling, the approach captures market volatility, water rights constraints, and uncertainties in utility demand, reflecting evolving land use and optionality in value. Results reveal substantial hidden value and superior risk-adjusted appraisals over classical methods, offering a robust model for sustainable mineral asset redevelopment that supports investors and municipalities navigating multi-phase, regulation-driven projects.

3:45 pm

Applications of Environmental Tracers to Improve Solute Transport Predictions

N. Thiros; Trihydro Corporation, Austin, TX

Quantifying contaminant transport through groundwater systems remains a persistent challenge. We demonstrate how environmental tracer observations can enhance predictions of groundwater residence time distributions and solute transport dynamics. At a uranium-contaminated site, we show that incorporating environmental tracer observations into numerical reactive transport model calibrations reduces solute transport predictive uncertainties. In a mountain watershed with uncertain groundwater and metal fluxes, environmental tracer data reveals complex mixing of groundwater with residence times that range from decades to centuries. These case studies illustrate the value of environmental tracers in constraining groundwater transport dynamics and improving hydrogeologic conceptual and predictive models.

Tuesday, February 24 Afternoon

HEALTH & SAFETY: TRAINING THAT STICKS: FRESH APPROACHES TO HEALTH AND SAFETY LEARNING

Sponsored by RioTinto

250A

Chairs: ***L. Sims****, Professional, Yerington, NV*
R. Reed*, University of Arizona, Taylor, AZ*

2:00 pm

Introductions

2:05 pm

Respirable Dust: A (Microscope) Picture is Worth a Thousand Words

M. Jaramillo Taborda and E. Sarver; Virginia Tech, Blacksburg, VA

The link between respirable mine dust and occupational lung diseases like Black Lung and silicosis is well established. Nevertheless, complacency in the workplace can be driven by several factors, including the fact that respirable-sized particles are too small to see with the naked eye. Rapid and real-time dust monitoring tools are gradually becoming more available, and these can serve an important role in worker training wherein exposure data can be quickly related to specific in-mine conditions. However, as with many health hazards, the latency of dust-related disease symptoms makes it difficult to fully appreciate, in the moment, negative outcomes that might not appear for years or decades. To better demonstrate this connection, microscopy data may be impactful because it can enable visualization of real dust particles–and their effects on the lung. In this presentation, we will review specific applications of microscopy for imaging and characterizing respirable particles in both mine dust samples and lung tissue. The latter was first devised as a tool for 'medical geology', but the detailed visuals may substantially benefit worker education efforts.

2:25 pm

Neo-NPC: Using Large Language Models for Agentic Decision-Making in Computer-based Training Games and Simulations

S. Sethi, Y. Dong, J. Felker, N. Pham, R. Reed and L. Brown; The University of Arizona, Tucson, AZ

Computer-based games and simulations provide unique opportunities to explore learner decision-making under realistic conditions that address current health and safety trends on the worksite. We introduce Neo-NPC, a novel framework that couples Large Language Models (LLMs) with Unreal 5, a modern game engine, to create highly interactive, persona-driven training simulations. Neo-NPC enables AI-controlled non-player characters (NPCs) that can take on specific job roles, such as truck driver or loader operator, and respond dynamically to learner actions and queries using natural language. These AI-controlled NPCs are capable of executing standard operating procedures, performing workplace examinations, and exhibiting authentic behaviors and emotional states, allowing trainers to rapidly author collaborative scenarios for powered haulage, moving equipment, and emergency response. In this talk, we discuss our technical framework and applications of LLM-enabled NPCs in training, demonstrating an approach that bridges traditional games and simulation with generative AI to improve worker health and safety in the mining industry.

2:45 pm

The Power of Written Procedures

J. Fowler; National EWP, Elko, NV

Often overlooked, well-written procedures will improve both the safety and productivity of your operations. When used correctly, they will help with hazard recognition as well as standardizing both the way tasks are completed in the field and the way that employees are trained. But, in order for this to happen, the procedures need to be well written, detailed and user friendly. I managed a companywide campaign to improve our written procedures starting in 2019. We went from 150 very general procedures 6 years ago to today where we have over 880 detailed procedures. Working with a behavioral scientist from NIOSH/CDC I learned the best way to lay out a written procedures to make them as user friendly as possible. I will walk through the whole process and discuss the lessons I learned: From how to gain management buy-in for a project like this to the best way to write procedures to gain employee buy-in and finally how to make them easy to read, understand and find.

3:05 pm

Leveraging VR Simulation for Fresh Approaches to Health & Safety Learning at Montana Tech's Underground Mine Education Center

C. Roos[1], S. Rosenthal[1], F. Estatuet[1], J. Hart[1], L. Birkenbuel[1], J. Reyes[2] and A. Schneider[2]; [1]Montana Tech, Butte, MT and [2]Yoy Simulators, Viña del Mar, Chile

This initiative demonstrates "Training That Sticks" by assessing the effectiveness of a Yoy Simulators' Load-Haul-Dump (LHD) simulator as a practical instructional tool for Montana Tech students before operating similar equipment in our on-campus Underground Mine Education Center (UMEC). The simulator was incorporated into the mining engineering "Practical Mining" course and expanded for additional trainees with a range of prior experience. The simulator teaches students the importance of pre-shift inspection and proper operational techniques using virtual reality. This presentation will provide an analysis of initial grading metrics for students from the simulation and future work will focus on following comparing simulation results with operational metrics in real-world conditions. Our aim is to quantitatively evaluate the influence of simulation-based education on health and safety outcomes, directly responding to the demand for innovative and effective training methods amidst financial and logistical limitations.

3:25 pm

Using Generative Pre-Trained Transformer-4 (GPT-4), ffmpeg, and Microsoft Azure to Aid in Creating a Text-to-Video Generation Tool to Improve Safety Shares and Incident Descriptions in the Mining Industry

T. Dias de Almeida[2], N. Nunes de Oliveira[3], C. He[2], C. Philipe Silva Rocha[1], M. Bandeira Teixeira[4], P. Rogers[2] and C. Kocsis[2]; [1]University of Nevada Reno, Reno, NV; [2]The University of Utah, Salt Lake City, UT; [3]Sierrita Operations, Freeport-McMoran, Green Valley, AZ and [4]Safford Operations, Freeport-McMoRan, Safford, AZ

Safety remains a critical concern in the mining industry due to the inherently hazardous nature of its operations. A common preventive measure is the use of pre-start safety meetings, where incidents and near misses are discussed. However, these sessions often rely on static formats such as PowerPoint presentations with photographs, which fail to fully convey the complexity and impact of real-life incidents. Occasionally, third-party simulations are used, but they can be costly and time-consuming, limiting their frequent use. This paper proposes a novel, cost-effective solution that leverages artificial intelligence—specifically GPT-4 and Microsoft Azure—to develop a text-to-video generation tool aimed at improving the realism and engagement of safety shares. The paper details the development process, showcases example outputs, and evaluates the tool's usability and potential benefits for enhancing safety communication in mining environments.

3:45 pm

Development of a Native Language Mining Chatbot: Enhancing Communication and Safety in the Mining Industry in Africa

M. Mashawi and R. Ganguli; University of Utah, Salt Lake City, UT

A native-language mining chatbot that enhances communication and safety in multilingual mining environments is being developed for Africa. It uses Large Language Models (LLMs) tailored for low-resource languages, and it trained with mining reports, safety manuals, native speaker interviews, and public datasets like OSCAR and Common Crawl. Preprocessing techniques noise removal and tokenization (e.g., Sentence Piece/BPE) ensure data quality. Domain adaptation includes industry-specific fine-tuning using FAQs, safety guidelines, and equipment manuals. The chatbot integrates intent recognition and Retrieval-Augmented Generation (RAG) to provide accurate responses, especially with real-time mining regulations. Deployment spans platforms such as WhatsApp, Telegram, and web apps, powered by Flask or FastAPI. Data scarcity and dialect variation challenges are addressed via synthetic data and geolocation-based model tuning. Future directions include multimodal input (voice, image) to better support field workers. The project demonstrates how native-language chatbots can improve operational efficiency, safety, and training in mining and potentially in other linguistically diverse industries

4:05 pm

The Limits of Regulation: Advancing Mining Safety Through Private Sector Innovation

D. Vilona; safety consultant, Vail, AZ

Despite decades of progress, fatal mining accidents in the U.S. have plateaued over the past ten years. MSHA's enforcement-based approach, while foundational, is no longer sufficient to drive further reductions in fatalities. Many incidents recur due to systemic issues—especially at small mining operations with limited resources for safety management. A growing need exists for private industry involvement to supplement regulatory efforts. Enhanced training, proactive risk assessments, improved standard operating procedures, and targeted cultural interventions can address gaps that regulations alone cannot fill. A modern MSHA–private sector partnership could include joint development of scalable training modules, shared safety data analysis, and deployment of independent safety consultants to high-risk sites. By working together, the mining industry can build stronger, more sustainable safety cultures that go beyond compliance and lead to measurable reductions in risk and fatality rates.

4:25 pm

Safety Outcomes of Active Learning-Based Training Programs

R. Reed, N. Pham and L. Brown; University of Arizona, Taylor, AZ

Objective: To evaluate the effectiveness of augmented training programs implemented at two underground coal mines (Partners A-B) and one underground metal mine (Partner C). Methods: From Partner A, 138 frontline supervisors, managers, and executive teams participated in our 2-day leadership course. Partners B-C implemented our MSHA New Miner and Annual Refresher training program, and our interactive computer game "Harry's Hard Choices". Data for the average annual injuries (AIR) and days lost per 100,000 hours worked (DLR) were obtained MSHA and compared for each partner and all other mines of the same type (excluding abandoned mines). Results: Partner A reported decreases in AIR (-30.0%) and DLR (-19.9%), compared to decreases of 5.1% and 31.0%, respectively, for underground coal mines. Partner B saw decreases in AIR (-20.0%) and DLR (-25.4%), compared to decreases of 5.5% and 22.0%, respectively, for underground coal mines. Partner C reported decreases in AIR (-50.0%) and DLR (-69.4%), while underground metal mines saw decreases of 2.7% and 5.0%, respectively. Conclusion: Injury and days lost rates decreased following implementation of the partner-selected training interventions.

Tuesday, February 24 Afternoon

INDUSTRIAL MINERALS & AGGREGATES: CRITICAL AND BATTERY MINERALS II

250C

Chairs: ***O. Yavuzkan****, Clariant, Wilton, CT*
D. Johnson*, Stantec, Phoenix, AZ*

2:00 pm

Introductions

2:05 pm

Microwave-Assisted Organic-Acid Leaching of Major and Critical Elements from Olivine: Characteristics, Kinetics, and Method Comparison

S. Ghaderi and W. Zhang; Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA

Olivine is a promising source of Ni and Co to meet the growing global demand for critical minerals. This study compared microwave-assisted leaching of major (Mg, Si, Fe) and critical (Ni, Co) elements from olivine with autoclave and conventional methods using organic acid media. The effect of various operating factors was evaluated using response surface methodology with a central composite design. Optimal conditions were [citric acid] = 0.84 M, S/L = 2.6%, t = 29 min, and T = 178 °C. Microwave-assisted leaching achieved higher extraction efficiency than other methods. Kinetic data were fitted using the Avrami model, revealing diffusion-controlled behavior. Solid residue analysis revealed that in microwave leaching, Si-rich layers detached from unreacted particles, facilitating better extraction, whereas in autoclave leaching, these layers remained, hindering progress. The study offers insights into the leaching behavior and kinetics of olivine in organic acids. Understanding major element leaching is essential, as Ni and Co are embedded in the silicate structure. Additionally, the resulting leachate rich in Mg and Fe is suitable for carbon fixation.

2:25 pm

Heavy Minerals Mine Waste from Central Texas Sand Mines: A Potential Source for Critical Minerals

B. Elliott, S. Short and J. Kyle; University of Texas at Austin, Austin, TX

Heavy mineral sands identified as waste material from industrial sand operations in Texas show enrichment in Ti, REE, Y, Th, and U. Zircon, monazite, magnetite, rutile, ilmenite, and other heavy minerals have elevated REE, Ti, Zr, U and V. Ti and V are predominantly sourced from Fe and Ti oxides, leucoxene, rutile, magnetite, and ilmenite. Heavy sand separates from existing sand mines (~2% mined material) show very high concentrations of REEs, > 1000 ppm for many REEs, notably Pr, Nd, and Dy. Preliminary results suggest that physical processing quickly concentrates REEs within heavy mineral sands to ~4% total REE+Y.

2:45 pm

Efficient Leaching of Critical Metals from Spent NCM Black Mass Using a Ternary Deep Eutectic Solvent Under Mild Conditions

Y. Wang and W. Zhang; Virginia Polytechnic Institute and State University, Blacksburg, VA

The rapidly growing demand for lithium-ion batteries has led to a surge in spent LIBs and a corresponding demand for critical elements, posing serious environmental and resource challenges. Hydrometallurgical processes employing deep eutectic solvents have attracted considerable attention for their potential for efficient metal recovery and lower environmental impact. In this study, various DES systems were systematically evaluated for their ability to efficiently extract critical metals from spent NCM black mass. Preliminary results demonstrated that a DES composed of guanidine hydrochloride, ethylene glycol, and maleic acid exhibited superior performance under mild conditions, achieving recovery of over 97% for Li, Co, Mn, and Ni. The underlying mechanisms were further investigated using a range of analytical characterization techniques. Additionally, the solvent was readily recoverable, enabling the establishment of a closed-loop recycling process. The maleic acid-based DES system is not only easy to synthesize and highly effective but also aligns with the sustainability principles, highlighting its promising potential for practical application in LIB recycling.

3:05 pm

An Innovative Non-TOFA Collector for Spodumene Flotation with Robust Performance

G. Wang, Z. Gu, B. Chen and A. Sousa; Arkema, Mulberry, FL

Tall Oil Fatty Acid (TOFA) is a widely used collector in spodumene flotation due to its effectiveness under standard conditions; However, its performance significantly deteriorates under adverse environments such as low temperatures and poor water quality. This study presents CustoFloat® Non-TOFA, novel non-TOFA collectors developed by Arkema, specifically engineered for enhanced flotation performance under such challenging conditions. Lab studies along with plant trials demonstrate that CustoFloat® Non-TOFA maintains stable concentrate grades and achieves improved lithium recovery even at temperatures slightly above freezing, where conventional fatty acids exhibit substantial performance losses. Innovative collector examples along with spodumene beneficiation flowsheet will be discussed.

3:25 pm

Bulk and Selective Leaching Approaches for Recovery of Critical Minerals from Thermally Treated NCM Black Mass

J. Wijenayake, L. Mseteka, A. Luyima, M. Moats and L. Alagha; Missouri University of S&T, Rolla, MO

The rapid growth of the EV industry has increased demand for critical minerals from spent Li-ion batteries. This study explored the recovery of lithium, nickel, cobalt and manganese from NCM black mass via bulk and selective leaching. Thermal pretreatment at 450 °C removed binders, enabling >90% simultaneous metal recovery with mild sulfuric acid leaching, while controlled-Eh water leaching dissolved >70% lithium selectively. High-temperature pretreatment (900 °C) with an additive achieved >95% lithium and manganese selective recovery under mild acid leaching conditions. Thermodynamic analyses confirmed feasibility, and two distinct, industrially viable flowsheets are proposed for efficient critical mineral recycling. Key words: NCM black mass, thermal pretreatment, bulk leaching, selective leaching.

Tuesday, February 24
Afternoon

INDUSTRIAL MINERALS & AGGREGATES: MINE DESIGN IN INDUSTRIAL MINERALS AND AGGREGATES

250D

Chair: ***R. Mitra****, South Dakota Mines, Rapid City, SD*

2:00 pm

Introductions

2:05 pm

26-011

LaModel Calibration for Stone Pillar Stability

C. Newman[1] and A. Minckley[2]; [1]Appalachian Mining & Engineering, Inc., Lexington, KY and [2]University of Kentucky, Lexington, KY

With underground stone operations developing in deeper and more geologically complex conditions, accurate pillar stability analysis becomes for the evaluation of engineering design. This paper provides engineering-based recommendations for applying LaModel to evaluate multiple-level room-and-pillar stone mines in both shallow and deep cover. It provides practical guidance on model calibration using field observations, selection of input parameters, and interpretation of results to inform design and operational decisions. The analysis demonstrates LaModel's effectiveness in simulating pillar load transfer, stress redistribution, and failure mechanisms in complex mining geometries where empirical methods may be inadequate.

2:25 pm

From Dewatering to Discharge: Building a Resilient Water System through Adaptive Management at Vulcan Materials Hermitage Quarry

V. Kona; Vulcan Materials Co, Brentwood, NH

Vulcan Materials executed a multi-phase initiative at its Hermitage Quarry to engineer a resilient, compliant water management system. The project addressed critical needs by centralizing pumping into a new 40-foot-deep, 10-year-life sump, enabling uninterrupted mining of reserves. To guarantee power security for six critical turbine pumps, the electrical infrastructure was overhauled by relocating substations to higher ground to protect against seasonal flooding. To ensure environmental compliance and mitigate violation risks, a polymer dosing system was integrated. This system features a polymer makeup unit, concrete & lined settling ponds, and a Hach turbidity monitoring system for precise process control. The project transformed a dewatering plan into a comprehensive solution, securing operational uptime and achieving sustainable, compliant water discharge.

2:45 pm

The Effect of Element Size and Lamination Thickness on Pillar Stability Factor When Applying LaModel to Underground Stone Mining

B. Diddle and Z. Agioutantis; University of Kentucky, Wilmore, KY

This work discusses work performed in StabMap, a program that allows users to seamlessly apply the boundary element method incorporated in LaModel to stone scenarios. The effect of both element size and lamination thickness on pillar stability factor was examined. Results were compared to the S-Pillar empirical equation. This work attempts to further integrate numerical methods with empirical methodologies for underground stone mine design.

3:05 pm

Geologic Effects on Mine Design

E. Rose; Barr Engineering Co., Salt Lake City, UT

This talk provides an overview on how geologic conditions affect highwall slope stability and the ability to safely mine in areas with potential ground control hazards. Factors such as geology, structural influences, groundwater, surface water, and mining practices all influence mine design. This presentation will review how these factors can affect mining activities and mine stability. Additionally, this presentation will highlight best practices for spotting signs of potential slope instability in aggregate mines.

3:25 pm

Practical Mine Design and Improvements to Maximize Mine Life

C. McCannon; RESPEC, Lexington, KY

For both surface and underground operations, producers have been looking to extend the life of their mine sites. A similar process and methodology can be applied to a variety of sites, to confirm geology, reassess the status of permitting and environmental factors, understand regional markets, and optimize site infrastructure in a way that allows for the overall mine footprint to be expanded. Operations have been gaining a better understanding of their resources and reserves for US SEC reporting, and data can be used to help with planning decisions such as equipment selection and overall site economics.

3:45 pm

Decision Logic for Managing Sub-Economic Mineral Resources: Process or Relocate?

A. Kuhn; Mineral Technologies, Saint Simons Island, GA

Determining whether sub-economic mineral resources should be processed or treated as interburden requires a structured economic and spatial analysis. This presentation outlines a multi-step logic framework applied within block modeling software to optimize this decision. The approach begins by identifying sub-economic mineral resources within the ultimate pit limits, isolating regions of sufficient size for potential earth-moving relocation. A cost-benefit comparison then evaluates processing costs versus the expense of relocating material with conventional earth-moving equipment. This methodology enhances resource utilization, supports dynamic mine planning, and improves economic outcomes by ensuring that each material movement maximizes value recovery or minimizes cost.

Tuesday, February 24
Afternoon

MINING & EXPLORATION: GEOSCIENCE: FROM ROCKS TO RICHES: GEOLOGY'S IMPACT ON MINING

250F

Chairs: ***K. Schafer****, RioTinto - Kennecott, Herriman, UT*
S. Briscoe*, Newmont Mining*

2:00 pm

Introductions

2:05 pm

Minerals Exploration in Multi-Generational Mining Districts in Utah and the Eastern Great Basin

S. Mills; Utah Geological Survey, Salt Lake City, UT

It is well documented that many mineral districts in Utah and the eastern Great Basin are multi-generational, i.e. they have experienced multiple, temporally and genetically discrete stages of deformation, magmatism, and/or mineralization. However, methodologies on how to approach exploration in these districts, which often have some historical mining production and existing paradigms on geological models, are lacking. Recent studies by the Utah Geological Survey (UGS) have demonstrated how a multi-chronometer approach to geochronology, partnered with detailed mapping and re-evaluation of existing models, can reveal unrecognized mineral potential and insights into complex regional tectono-metallogenic evolution. Among these new discoveries include recognition of Cretaceous magmatism, previously thought to be nearly non-existent in Utah, in some of Utah's most significant and unique critical mineral deposits, which introduces new possibilities for how these deposits were formed and/or enriched. This talk presents results of UGS studies to date and makes suggestions for a systematic approach to modern exploration in multi-generation, historical mining districts.

2:30 pm

Field Notes from the Frontline: Geology, Land Use, and the Future of Exploration

M. Travis; Arkenstone Exploration, Elko, NV

As markets chase critical minerals and policymakers reshape the land-use landscape, geology remains the bedrock of responsible exploration. This talk examines how geological insight—through resource definition, structural interpretation, and deposit modeling—guides not just discovery, but the evolving standards of ESG, permitting, and investor expectations. Public lands, increasingly contested, demand vigilant stewardship. Exploration geologists stand at the frontier, protecting access through continual prospecting and detailed understanding of mineral systems. Only by embracing this role can we maintain multiple-use integrity, find balance between preservation and progress, and fulfill our deeper purpose: advancing civilization through the ethical development of Earth's resources.

2:55 pm

Constraining Pit-Scale Geological Models with Structural-Geologic Analyses: Examples from the Bingham Canyon Copper Porphyry, Open-Pit Mine, Utah, USA

K. Schafer, J. Ellis Evans and J. Gibbs; RioTinto - Kennecott, Herriman, UT

At the Bingham Canyon Mine, using structural-geological analyses to refine pit-scale, 3-D geologic models is crucial for accurate ore distribution predictions and pit design. By identifying and correcting kinematically inadmissible models through 2-D and 3-D kinematic restorations and forward models, we ensure that stratigraphic volumes are conserved and fault juxtapositions are kinematically-viable. Revising the pit-scale model with structurally-admissible forward models not only improves the model's reliability but also provides data-collection opportunities, including new drilling targets. This approach can significantly enhance the understanding of ore-resource volumes and their spatial distribution, leading to more efficient and targeted mining operations.

3:20 pm

Orebody Knowledge Lessons Learnt from the Argyle Diamond Deposit

M. Rayner; Rio Tinto, Perth, WA, Australia

The Argyle (AK1) pipe in the Kimberley region of Western Australia is the world's largest source of natural diamonds, which produced more than 900 million carats of diamonds to its closure in November 2020. Argyle diamonds are distinctive in having a predominance of brown colours and rare highly-prized pink diamonds, which are a signature of the deposit. Significant modifications of the geological model towards the end of mine life have resulted following the commencement of underground block cave operations, producing several critical lessons learnt. Diamond grade and quality reconciliation issues warranted a geological investigation which resulted in numerous new volcaniclastic olivine lamproite domains being discovered with recognition of a broad range of low to very high-grade units. The new lamproite domains had a significant effect on the block cave mining and resultant recovery of diamonds. The result of the study was a more coherent and detailed geological understanding of the volcanic emplacement and paragenetic sequence of the Argyle AK1 pipe. Structural modelling of the deposit also played a major role in the block cave mining tonnage recoveries and daily operations.

3:45 pm

Grade Control Drilling Strategy at the Leeville Underground Complex

S. Womack; Nevada Gold Mines, Elko, NV

Minimizing mine plan risk at the Leeville Underground Complex on the Carlin Trend requires balancing drill hole density while testing litho-structural and resource models. The mean geotechnical Rock Quality Designation for Leeville is in the "Poor" classification thus oriented structural data is derived from underground mapping which makes pre-mining models subject to multiple interpretations. Historically, drilling followed rigid grids; our current approach tests model scenarios at wider spacing with a focus on generating high resolution models. Consequently, our geologic constraints on the orebody have become more precise at the expense of sample density and at the risk of incorrect interpretations.

Tuesday, February 24
Afternoon

MINING & EXPLORATION: GEOSCIENCE: MINE DEWATERING AND DEPRESSURIZATION: HYDROGEOLOGY STRATEGIES FOR SURFACE AND UNDERGROUND MINING

255B

Chairs: ***E. Hover****, Rio Tinto Plc, South Jordan, UT*
B. Nock*, Montgomery & Associates, Tucson, AZ*

2:00 pm

Introductions

2:05 pm

Integration of Pore Pressure and Geotechnical Analysis

G. Beale and J. Dowling; Piteau Associates, Shrewsbury, United Kingdom

Groundwater models and analytical method are often poorly focused on pore pressures that are relevant to geotechnical instability. A high proportion of geotechnical instabilities occur at relatively shallow levels in pit slopes. There is increasing awareness of the importance of water in the Excavation Damaged Zone (EDZ) where infiltration, shallow water percolation and rapid changes in pore pressure can occur in defects that have low confining stresses, and where the consequences of transient or longer-term pore pressure changes are greater, particularly in marginally stable slopes. Water may also create a component of driving force within defects, or across geological boundaries where a "stepped" hydraulic gradient develops. This paper discusses methods to characterize and quantify pore pressures and how best to input pore pressures to geotechnical analysis of pit slopes. Several case studies are presented.

2:25 pm

Integrated Depressurization Strategies and Real-Time Slope Stability Monitoring at Freeport-McMoRan Using a Customized Geomechanical Platform

A. Soni[1], A. Wamweya[1], J. Burrola[1], F. Ismaya[3], L. Tejada[1] and B. Shriver[2]; [1]Freeport McMoRan, Tucson, AZ; [2]REI Drilling, Salt Lake City, UT and [3]Freeport McMoRan, Bagdad, AZ

At Freeport-McMoRan's Bagdad mine, an integrated approach to slope stability combines advanced depressurization and real-time monitoring. Directional drains (or spaghetti drains), strategically angled to intersect deep saturated zones, effectively reduce pore water pressures that drive instability. These drains also complement a depressurization infrastructure comprising of shallow wells and horizontal drains. This targeted depressurization has improved slope performance and preserved bench integrity, supported by real-time piezometric data and numerical modeling to minimize redesign challenges. To enhance decision-making, a custom geomechanical platform was developed for in-house data management and visualization using Power BI. It consolidates sensor inputs—piezometers, prisms, GPS—into interactive dashboards with time-series analysis of deformation and pore pressure trends with automated alerts. Scalable and modular, the platform enables user-centric future integration with predictive models, representing a significant step toward Freeport's proactive slope management transformation in geomechanical risk management while sustaining operational safety and future pit expansion.

2:45 pm

Directional Drilling for Surface and Underground Depressurization

D. Brunner and B. Shriver; REI Drilling Inc., Salt Lake City, UT

Current mine depressurization practices involve drilling boreholes into benches or in advance of underground workings using air-hammer or rotary drilling techniques. These depressurization boreholes are typically limited in depth, not guided or precisely placed, and short-lived, providing only marginal benefits. Enhanced capabilities developed over the last decade now provide directional drilling solutions to both surface and underground hard rock mines for water and gas depressurization. Long, >2500 ft, feature-focused boreholes developed with multiple tangential branches, each targeted into specific gas or water bearing zones or faults, and each individually stabilized with a perforated liner, can create expansive drainage networks that will produce significant volumes for long periods from a single borehole collar. This paper provides a technical overview of two successful depressurization projects at base metal mining operations; a highwall stabilization project at an open pit mine where boreholes were developed through specific water bearing faults, and a project involving a manifold developed under an orebody to mitigate water and gas emissions in advance of mine developments.

3:05 pm

Utilization of Historic Mine Workings to Bypass Active Mining Cut for Removal of Horizontal Drain Water

E. McBride; Rio Tinto, White City, UT

The Bingham Canyon Mine executes an annual horizontal drain drilling program focused on slope depressurization. The water removed via the horizontal drains has historically been collected in an HDPE pipeline that is routed onto subsequent benches until an engineered collection point is reached. The pipeline routing strategy poses a risk to mine production and slope stability by focusing water into active mining cuts around pipeline discharge points. The risk increases as mining progresses as collection points can be up to 1,000 vertical feet apart with additional water added to the pipeline with each bench. To mitigate this risk, a 650' passive vertical drain was designed to route the horizontal pipeline water into a historic mining tunnel, which gravity feeds water to a collection point away from the open pit mining operation. This paper describes the design and execution of the passive vertical drain, as well as the risks identified, and the controls adopted to mitigate these risks.

3:25 pm

Bedrock Dewatering Challenges Influenced by Hydrogeologic Compartmentalization

J. Fox and E. Ansah; WSP, South Jordan, UT

Hydraulic heterogeneity is a recurrent and often overlooked challenge when designing and implementing a mine's dewatering system. A lack in understanding of a mine site's groundwater flow system may misinform groundwater flow model calibrations, impact assessments, and dewatering management, leading to operational inefficiencies, misleading performance, potential slope instabilities, delays, and ultimately increased costs. To reduce this uncertainty, a site's compartmentalization and its scale require careful conceptualization and characterization using three-dimensional visualization tools and field assessment methods. The evaluation of potentiometric surface variations, vertical and lateral discontinuities, and changes in permeability across barriers and structures are critical considerations when evaluating a site's dewatering feasibility. This presentation outlines the best practices and strategies to employ when conceptualizing a mine site's groundwater flow system. The discussion will include a description of the fracture flow principles that require detailed hydrogeologic characterizations and the shortcomings of applying equivalent porous mediums in conceptualizations.

3:45 pm

Probabilistic Modeling of High Resolution Surface Water Flow Using Daily Timesteps in GoldSim

T. Cluff and J. McNeil; Piteau Associates, Reno, NV

Surface water flow in arid environments is strongly influenced by storm duration and rainfall intensity. Hourly, or shorter, precipitation records are used to develop flow hydrographs and cumulative discharge. Mine site water balances use daily time steps because they are concerned with the quantity of surface water runoff produced and its effect on the water balance. Dynamic water balance modeling codes, such as GoldSim, typically use daily timesteps for ease of use and to match internal records. The problem is that the calculation of surface water runoff using daily timesteps may underestimate flow because the storm event is averaged across a 24-hours, lowering the storm's true intensity. This study uses hourly precipitation data and HEC-HMS to develop precipitation criteria for storm events that produce surface flows and a statistical assessment of runoff frequency and magnitude. This analysis establishes the minimum precipitation criteria for storm events that produce surface flows. Scaled daily precipitation data is then used in GoldSim to validate predicted runoffs to HEC-HMS. A layer of probabilistic analysis is included because of the statistical nature of the assessment.

Tuesday, February 24
Afternoon

MINING & EXPLORATION: INNOVATION & TECHNOLOGY: TRANSFORMING MINING OPERATIONS WITH AI: INNOVATIONS AND FUTURE DIRECTIONS

Sponsored by Newmont

255F

Chair: ***A. Moharana****, WSP, Tucson, AZ*

2:00 pm

Introductions

2:05 pm

Application of AI in Mine to Mill Reconciliation: A Conceptual Idea

A. Samal; GeoGlobal LLC, Riverton, UT

The mine to mill reconciliation is a process that allows to learn about the success and failure in mine production and provides reasons for those outcomes. Success in annual production may be due to many reasons, such as a good mine plan based on a robust resource/ reserve model; excellent understanding of the rock types mined during that timeframe, reliable laboratory services, and a disciplined work culture led by a competent workforce. Therefore, reconciliation is a function of many variables, some of which can be controlled, and many of them are geological. Due to the complex nature of the workflow and the nature of the important variables, it is extremely difficult to create a predictive model. However, it is possible to use the prior years' knowledge and learn from the data to generate a predictive model using AI techniques. This presentation is meant to start a healthy discussion on this concept of using an automated system backed by rich data that can predict productivity, which in turn can be used by the management team as a tool for improving productivity in a mining operation.

2:25 pm

Predictive Analysis of Human-Machine Safety Incidents in Mining Operations Using AI/ML: The Impact of Environmental and Social Factors on Safety and Production

A. Obregon, J. McGraw and C. Smith; Newmont Corporation, Sahuarita, AZ

Mining operations present critical safety risks where human operators and heavy machinery intersect. This study investigates AI/ML methodologies to analyze and predict safety accidents and near misses between machines and humans in mining environments. The research examines the influence of external factors including weather conditions, shift scheduling patterns, and major sporting events on incident occurrence and production performance. By integrating sensor safety data and fms geolocation data with these non-conventional variables, the study develops predictive models to identify high-risk periods and conditions. The methodology employs machine learning algorithms to process incident data, meteorological data, workforce scheduling records, and regional sporting event calendars. This comprehensive approach aims to enhance safety protocols through proactive risk identification while maintaining operational efficiency and production targets in mining environments. Keywords: mining safety, machine learning, predictive analytics, human-machine interaction, weather impact, workforce scheduling, sporting events, production optimization, accident prevention

2:45 pm

Advancing Dynamic Mine Planning Using AI-Enabled Decision Support

R. Nunes, N. Risso and M. Momayez; University of Arizona, Tucson, AZ

Dynamic mine planning demands rapid decisions under shifting conditions. Traditionally, planning relies on static analyses and manual inputs, limiting flexibility and reaction time. We present a practical approach that embeds LLM powered AI agents into mine planning workflows. Agents enable interactive work and timely responses to trigger driven events and production shifts. Data access and tool calls are coordinated through MCP servers. In a pilot, the system recomputed alternative Lerchs Grossmann pit shells when triggers occurred and summarized impacts on reserves and economic effects for the team. We note integration lessons and gains in agility, precision, and efficiency.

3:05 pm

Scalable, Low-Cost Displacement Monitoring of Mining Areas Using AI & Open-Source Tools

S. Karim, B. Nojabaei and H. Foroutan; Virginia Polytechnic Institute and State University, Blacksburg, VA, Blacksburg, VA

This study presents a Python-based framework that leverages Sentinel-1 derived InSAR and AI-driven time-series analysis for long-term displacement monitoring in mining areas, including waste dumps, tailings, and stockpiles. As a low-cost and scalable extension to ground-based monitoring systems, the approach utilizes freely available Sentinel-1 satellite imagery with a 6–12 day revisit cycle to generate high-resolution displacement time series with millimeter-level precision. Using open-source tools and machine learning algorithms, the framework enables automated detection of potential displacement zones, long-term trends, and anomalies with resolution up to 1–3 mm/year. A case study from a mine in Arizona, USA, demonstrates its potential for continuous, automated geotechnical risk assessment.

3:25 pm

Autonomous Decision Loops in Mining: Integrating Explainable AI and Human-in-the-Loop Feedback

S. Güngör, E. Anderson, Y. Tuncer, A. Akgün and D. Challenger; airth.io, Tucson, AZ

Current mining automation efforts often fail due to a lack of transparency and trust in AI- generated decisions. Operators resist AI because recommendations lack contextual explanations, and feedback loops between humans and systems are either absent or non- functional, all of which undermines the progression to semi- or fully autonomous operations. This work presents how an AI-integrated decision framework (AIDF) can combine automation with human-in-the-loop design. Instead of replacing human judgment, the AIDF captures operator feedback to dynamically improve model performance. Explainable AI components ensure transparency behind each recommendation, such as haul route or equipment scheduling. To further enable understanding of why certain choices were made and how they relate to project goals, traceable decision logs are implemented. The result is a trusted, auditable system where operational variability decreases, and autonomous workflows evolve organically. This model lays the foundation for transparent and progressive mining autonomy and stands to enhance operator trust and increase technology adoption.

3:45 pm

Innovation Bottlenecks in Mining and the Emerging Role of AI in Bridging the Gap - A Case Study

A. Ashok Parmar; Clareo Partners, Chicago, IL

With the accelerating demand for raw materials to support critical industries—commodities such as copper, lithium, and rare earth elements are in significantly higher demand. However, the mining industry continues to face major hurdles across the supply chain, including geopolitical instability, permitting delays, and the increasing difficulty of discovering new deposits. These challenges underscore the urgent need for innovation across the mining value chain. This paper will examine current challenges in the mining sector, with a particular focus on both upstream (exploration) and downstream (metal production enhancement through tailings reprocessing). It will highlight how innovation groups within major mining companies are actively engaging with the startup ecosystem to co-develop solutions with a case study to illustrate both the operational obstacles and opportunities in modern mining. The paper will pay special attention to base metals, particularly copper. Additionally, it will share insights on how mining innovation teams can collaborate more effectively with corporate venture arms to accelerate breakthrough solutions across mining and adjacent sectors.

Tuesday, February 24 Afternoon

MINING & EXPLORATION: MANAGEMENT: MINE DATA MANAGEMENT

250E

Chair: ***A. Rasti****, Freeport McMoRan, Morenci, AZ*

2:00 pm

Introductions

2:05 pm

Strengthening your Management Operating System: The Key to Resolving Daily Tonnage Shortages, Equipment Availability Issues, and Other Operational Challenges

D. Truchot; Hanzehogeschool Groningen, Groningen, Groningen, Netherlands

Gain practical knowledge of how to design, implement, and sustain a Management Operating System (Operations / Maintenance) Management Operating Systems (or MOS) are not well understood, and this course aims to share our expertise and some of the key tools to start identifying gaps and missing links that slow your organization' successes and launch sustainable correction action plans. We will review with you best practices that are in use in the pits or in maintenance workshops and share some of this insider knowledge so you can start optimizing your operations. Some of the key tools we will review are: Leader Standard Work, Short Interval Controls, DWOR (Daily Weekly Operating Reports), Skills Flex Matrices, Variance Reports, Robust Action Logs, and Root Cause Corrective Action tools & processes (RCCA). We will provide you with a critical approach and a proven suite of tools that are used underground, in daily production meetings, at dispatch, or in maintenance workshops, day in / day out. We will also share with you some of the pitfalls and strategies to ensure your changes are sustainable.

2:25 pm

Mine Planning Enhanced by Integrating Sensor Data

H. Lang[2] and T. Norris[1]; [1]Dassault Systèmes Canada Inc, Vancouver, BC, Canada and [2]MineSense Technologies, Vancouver, BC, Canada

Real-time equipment sensor data is emerging as a key enabler of efficiency, providing critical information after short-term block models are created to support just-in-time decision making. However, the large amounts of data generated by these sensors are rarely leveraged to inform and optimize short-term mine planning in a closed feedback loop. This case study illustrates a methodology integrating non-traditional datasets into traditional mine planning platforms. The work presented applies this methodology to the integration of Minesense's ShovelSense data with GEOVIA Surpac mine planning software. The integration allows Surpac to seamlessly ingest, display and interpret the high-resolution bucket- and truck-level grade data from ShovelSense. As a result, mine planners and geologists can incorporate real-time data directly into short-term planning workflows. Linking the information from mine-to-mill optimization sensors with mine planning software will allow smarter material routing, improved reconciliation between plan and plant, reduced ore loss and dilution, leading to better operational and financial outcomes

2:45 pm

TopVu OreTracking: Unlocking Valuable Data for Ore Management

Y. Brulé; TopVu, Sudbury, ON, Canada

OreTracking systems are increasingly gaining traction worldwide among geologists and mill operators as a valuable tool for enhancing operational efficiency. The OreTracker integrated system is employed in a range of critical applications, including grade control, mineral reconciliation, waste dilution monitoring, and developing a comprehensive understanding of ore handling circuits. In this paper, TopVu provides a quick overview of the OreTracking methodology, followed by insights from client interviews. These insights shed light on the primary drivers behind the adoption of OreTracking systems and the key benefits users realize from leveraging the collected data.

3:05 pm

Broadening the Lens: Evolving Multi Disciplinary Disclosure Practices in Mining

K. Timboe and J. Heyes; Quartex Software, West Perth, WA, Australia

Disclosure practices in the mining sector are evolving to meet growing expectations for transparency, consistency, and long term accountability. This paper compares reporting frameworks across international jurisdictions, identifying best practices and gaps. It advocates for broader, systemised disclosure that integrates technical, financial, and ESG dimensions, including resource and reserve reporting, aligned with the intent of JORC and NI 43101. Mine closure liabilities serve as a case study to illustrate how enhanced governance and cross disciplinary coordination can reduce risk, build stakeholder trust, and position disclosure as a strategic tool for responsible resource development.

3:25 pm

Ore Blending Strategy in Mine-to-Mill Operatons Using the Simplex Method at PT. Agincourt Resources

G. Setyorini; PT. Agincourt Resources, Batu City, Jawa Timur, Indonesia

PT Agincourt Resources is a gold mining company based in Kelurahan Aek Pining, Batangtoru, South Tapanuli, North Sumatra, located along the Sumatra Fault Zone with high-grade gold and silver deposits. Mining operations include Pit Purnama, Pit Ramba Joring, and Pit Barani, processed using Carbon-In-Leach (CIL) facilities. Purnama and Ramba Joring are high-sulfidation epithermal deposits, while Barani is a low-sulfidation vein system with unique geological and metallurgical traits. To improve mine-to-mill performance, an ore blending strategy using the simplex method has been applied to control feed variability and enhance recovery. By combining ores of different grades, this approach ensures stable feed grade, better recovery based on geometallurgical properties, and lower processing costs. The strategy supports long-, medium-, and short-term planning, guided by parameters such as Au (g/t), Ag (g/t), Cu (g/t), CuCn (g/t), Sxs (%), Recovery (%), PLi, and Gold Recovered (oz). Blending using the simplex method has improved feed consistency, grade control, and reagent use during extraction.

3:45 pm

A Comparison of Lateritic Bauxite Mapping Indices Using Multispectral and Hyperspectral Remotely Sensed Data

M. Sahoo[1], B. Behera[1], S. Bisoyi[2] and B. Pal[3]; [1]Indian Institute of Technology (Indian School of Mines), Dhanbad, Dhanbad, Jharkhand, India; [2]Indian Institute of Engineering Science and Technology, Shibpur, Shibpur, West Bengal, India and [3]National Institute of Technology, Rourkela, Rourkela, Odisha, India

Lateritic bauxite deposits are an important economic resource for the mining industry. Remote sensing offers a cost-effective means of mapping these deposits over large areas. This study compares the effectiveness of selected spectral indices for mapping lateritic bauxite using multispectral and hyperspectral data acquired from Sentinel-2 and EnMAP missions respectively. Based on diagnostic iron oxide and hydroxyl absorption features, the Lateritic and Modified Lateritic indices were evaluated for a region of interest near an opencast bauxite mine. Sentinel-2 data provided moderate spatial resolution with broad spectral bands, while EnMAP hyperspectral data enabled detailed mineral discrimination due to its high spectral fidelity. Results showed a positive correlation for indices mapped (R^2 = 0.54, 0.56, % RMSE = 6.4%, 12.4%) indicating that hyperspectral data offered greater accuracy in differentiating bauxite from other lateritic soils, though Sentinel-2 remains useful for regional-scale mapping. Our study featured the trade-offs between spatial and spectral resolutions, providing insights into mineral mapping strategies.

Tuesday, February 24
Afternoon

MINING & EXPLORATION: MANAGEMENT: SAFETY AND CULTURE MANAGEMENT

255C

*Chair: **E. Guebe**, Freeport McMoRan*

2:00 pm

Introductions

2:05 pm

26-059

Systems Engineering in Mining: Aligning People, Processes, and Culture for a Successful Change

S. Nowosad[1], A. Tobar Escudero[2] and S. Ergener[3]; [1]Curtin University, Kalgoorlie, WA, Australia; [2]Epiroc, Coslada, Madrid, Spain and [3]Epiroc Drilling Tools AB, Fagersta, Sweden

Technology implementation in mining often fails not due to technical shortcomings, but because of organizational resistance to change. This paper presents a case-scenario analysis of technology transformation efforts in complex mining environments, highlighting how systems engineering principles can be applied to manage the interdependencies between people, processes, and technology. In many cases, resistance is rarely irrational, but a result of misaligned incentives, insufficient communication, and cultural disconnects. By treating culture management as a core component of system design, mining leaders can reduce friction, foster engagement, and enable resilient transformations within their operations unlocking the full value of technological innovation. The practical insights presented aim to help mine leaders apply systems thinking to mitigate resistance, align cross-functional teams, and embed a lasting culture of innovation.

2:25 pm

"The Good Old Days Were Not That Good..."

P. Hover; Hard Rock Rescue, St. Onge, SD

Abstract for 2026 SME Safety and Culture Management Technical Session Paul "Woody" Hover, CMSP hardrockrsq@gmail.com 605-645-3450 A look back at the safety culture in mining at the time of the passage of the Mine Act of 1977 and the challenges and efforts of the mining industry and government to bring us to where we are today. The presentation will include factual and anecdotal accounts of the cultural shift in the industry based on the presenter's experiences after 40 some-odd years associated with the mining industry, with a look to the future

2:45 pm

Arc Flash Safety in Mining, Relationship between MSHA and NFPA 70E

U. Arvayo; Burns & McDonnell, Kansas City, MO

Arc Flash is becoming a growing concern in the mining industry, standards and regulations have evolved to protect employees from dangers of arc flash as detailed in NFPA 70E. All of which have been adopted by OSHA and is quickly becoming a termed industry standard. OSHA recognizes NFPA 70E however OSHA does not have jurisdiction in the mining industry. Electrical safety for mining is covered under CFR Title 30, Part 56/57 Subpart K. MSHA is responsible for enforcing electrical safety for mining operations, with almost no reference to protect electrical workers against arc flash hazards. MSHA is looking at OSHA in some cases to fill in these details as stipulated in the Mine Act, NFPA 70E has since removed the mining industry exclusion. How will this affect the mining industry, how can mines be prepared? This presentation will dive into the background and solutions on how to stay compliant with regulation, to inform its miners about the hazard risk categories, and appropriate PPE to protect the qualified worker while minimizing down time and costs.

3:05 pm

Safe Minds, Safe Mines: If You Think This Doesn't Apply to You, It Definitely Does

J. Loff-Peterson; Member, Mondovi, WI

When mine safety is discussed, many physical, chemical, and environmental hazards likely come to mind. However, psychological safety may not be one of the first considerations. Yet research shows that teams with high psychological safety are more likely to generate innovative ideas and experience a 40% reduction in employee turnover. Despite its powerful impact, many of us may not fully understand what psychological safety is, why it matters, or how to recognize whether our organization fosters it. In this presentation, we will explore the concept of psychological safety and explain why a thriving safety culture cannot exist without it. We'll discuss practical steps to foster psychological safety and examine the far-reaching benefits that extend beyond safety—such as improved production efficiency, reduced employee turnover, and increased profitability. Through real-world examples of both positive and negative psychological safety in the workplace, I'll share actionable strategies you can use to strengthen the psychological culture in your organization.

3:25 pm

Performance Audits – From Checklist to Catalyst: The Audit Reimagined Through Positive Human Interactions

E. Ramon Huergo; MD, Miami, FL

A tragedy led me to ask four radically simple questions: What is a good audit?... What is an Audit to the people on the ground? What is it to OH&S and top management? And how do you measure its performance; what do you celebrate? The answers exposed a silent failure. Audits have become rituals without meaning; checklists that miss the point, failing to reflect reality, reduce risk, or inspire true managerial reflection and action. But what if we reimagined the Audit? What if it became a true conversation about risk, a way to uncover root causes, detect bias and noise, and build operational reliability, without added cost, burden, or conflict? This presentation offers a new lens. Audits should Simplify. Clarify. Connect. They must move us from compliance to commitment, from oversight to insight, from isolated teams to a community, bound by purpose, care, and responsibility. This isn't just a technical issue. It's a human one. And the shift begins by asking better questions, and listening to the answers that truly matter.

Tuesday, February 24
Afternoon

MINING & EXPLORATION: OPERATIONS: OPTIMIZATION OF MINING OPERATIONS AND STRATEGIC PLANNING THROUGH MACHINE LEARNING & ARTIFICIAL INTELLIGENCE

255E

Chairs: ***J. Alves****, Rio Tinto, State College, UT*
J. Quiala*, Nevada Gold Mines*

2:00 pm

Introductions

2:05 pm

Data-Driven Velocity Optimization for Energy-Efficient Haulage in Open-Pit Mines

T. Chimbwanda, N. Risso and A. Anani; University of Arizona, Tucson, AZ

This study investigates the influence of haul truck velocity optimization on energy efficiency in open-pit mining operations. Using field data from a fleet management system at an active open-pit copper mine in the United States, the research quantifies how varying velocity profiles across haul road segments influence fuel consumption and energy intensity. A predictive model is developed to correlate ground speed, road gradient, and fuel burn rate. The model is subsequently validated using real-world operational data. Suboptimal velocity ranges are identified and data-driven recommendations were provided for operational adjustments that can reduce energy waste without compromising productivity.

2:25 pm

Uncovering Hidden Liabilities: Technical Debt in Mining Systems, Tools, and Teams

J. Snyder; Rio Tinto Plc, London, London, United Kingdom

As mining operations become more digitized and complex, technical debt can accumulate as hidden inefficiencies that compromise safety, productivity, and innovation. This presentation introduces a practical framework for recognizing and managing the types of technical debt across people, systems, tools, and processes. We examine how skill gaps, legacy infrastructure, underutilized platforms, and inefficient workflows accumulate into long-term liabilities. Drawing from cross-industry case studies, we propose actionable strategies for technical debt acknowledgement, governance models, tooling audits, documentation rigor, and cultural alignment. Attendees will gain a toolkit to detect early warning signs of technical debt and implement incremental and sustainable improvements.

2:45 pm

A Machine Learning Framework for Predicting Overbreak and Underbreak in Stopes and Its Effect on Mine Planning

D. Osei and A. Brickey; South Dakota School of Mines and Technology, Rapid City, SD

Overbreak and underbreak are phenomena that can negatively impact production and safety at underground mines, leading to excessive backbreak, roof instability, and ground fall hazards that can create an unsafe environment. This research applies machine learning, specifically artificial neural networks (ANNs), to predict overbreak and underbreak percentages for planned stopes. The ANN model predicts the estimated overbreak and underbreak percentages likely to occur during stope development. The model is trained using data from a case study mine that includes selected controllable and uncontrollable parameters recorded during and after stope mining. Additionally, the mine's production schedule is created using the Generalized Underground Resource-Constrained Project Scheduling Problem (UG-RCPSP) framework. This method provided a near-optimal solution based on resource constraints and activity precedence. The predicted overbreak and underbreak percentages are used to calculate new stope tonnages. This integrated approach enables the evaluation of how such deviations affect production efficiency and ultimately the Net Present Value (NPV) of the schedule.

3:05 pm

Estimating Haul Truck Component Reliability Using Survival Analysis

G. Mohaar; Wenco, Calgary, AB, Canada

In mining operations, the reliability of haul truck components is critical for minimizing downtime and optimizing maintenance strategies. This presentation explores various survival analysis techniques for estimating the Remaining Useful Life (RUL) of key truck components, enabling proactive decision-making and risk assessment in reliability engineering. We will discuss a comparative analysis of parametric and non-parametric models, including Weibull and Mixture Weibull modeling for characterizing failure distributions and Kaplan-Meier estimators for non-parametric survival estimation. The presentation will demonstrate how these techniques can be integrated into reliability-centered maintenance frameworks, improving component failure predictions and risk management. Using real-world haul truck failure data, we will evaluate the effectiveness of these models in capturing failure behavior under different operating conditions. The findings will provide actionable insights into maintenance optimization, risk-based decision-making, and extending asset lifespan in mining fleets.

3:25 pm

Global Standardization Through AI Vision: Optimizing Multi-Site Operational Performance with Shovel-Based Monitoring

S. Karimifard; Weir Motion Metrics, Vancouver, BC, Canada

For mining companies operating across multiple sites, achieving consistent performance and efficiency is a challenge. With the deployment of Shovel-Metrics™ Gen 3, operators standardize data collection and insights across their global fleet. This enables real-time GET monitoring, tooth wear analysis, and bucket-by-bucket fragmentation evaluation, reducing unplanned downtime and optimizing maintenance cycles. By integrating site-level data into a centralized MOTION METRICS™ platform, companies can benchmark performance across multiple operations, improve drill & blast efficiency, and minimize downstream impacts from GET loss or oversize material. This case study from a North American mining company illustrates how AI-powered vision supports strategic, data-driven decision-making.

3:45 pm

A Digital Decision Support System for Continuous Economic Optimisation of Underground Critical Raw Materials Mining Projects

M. Islam and H. Mischo; Technische Universitat Bergakademie Freiberg, Freiberg, Sachsen, Germany

Underground critical raw materials (CRM) mining is highly vulnerable to economic volatility and geological uncertainty, which often compromise project viability. To address these challenges, this study introduces a digital decision support system (DSS) for continuous economic optimisation throughout the mining lifecycle. The DSS leverages ensemble machine learning techniques to accurately predict optimal mining methods and cut-off grades, drawing on both real and simulated datasets. Through real-time data integration, dynamic re-optimisation, and re-calculation of net present value (NPV), the system strengthens decision-making under uncertainty, reduces financial risk, and promotes more sustainable and efficient extraction strategies in underground CRM operations.

Tuesday, February 24
Afternoon

MPD: CHEMICAL PROCESSING: REPROCESSING FROM SECONDARY RESOURCES

155E

Chairs: ***B. Ji****, Virginia Polytechnic Institute and State University, Blacksburg, VA*
Z. Cicek*, Freeport-McMoRan, Thatcher, AZ*
M. Rezaee*, Ph.D. student, State College, PA*

2:00 pm

Introductions

2:05 pm

Extraction of Lithium from Battery Recycling Wastewater Using a Synergistic Solvent Extraction System of D2EHPA and TBP

K. Kurniawan, A. Cueva Sola, J. Macholz and T. Dzwiniel; Argonne National Laboratory, LEMONT, IL

The recycling of spent batteries, such as lithium-ion batteries, presents significant challenges, notably the generation of substantial volumes of wastewater. This wastewater exhibits complex chemical characteristics, affected by both the inherent chemistry of the batteries and the specific process parameters employed during recycling. Interestingly, this wastewater contains economically recoverable components, including lithium. In this study, a solvent extraction (SX) process was explored to recover lithium from battery recycling wastewater. Initially, various commercial extractants were evaluated, such as D2EHPA, PC88A, Cyanex 272, LIX 84-I, TBP, and their combinations. The results indicate that D2EHPA + TBP system demonstrated synergism to advance lithium extraction. The effects of parameters, including D2EHPA concentration, TBP concentration, extraction time, initial pH, and aqueous-to-organic (A/O) ratio were ioptimized. A two-stage SX approach was employed to enhance lithium recovery. Lithium was stripped from loaded organic solution using sulfuric acid (H_2SO_4). The recyclability of D2EHPA-TBP was evaluated via four extraction-stripping cycles.

2:25 pm

Stepwise Oxido-Acidic and Thiocyanate Leaching for High-Efficiency Recovery of Base and Precious Metals from Waste PCBs

M. Rezaee; Ph.D student, State College, PA

This work evaluated a green route for developing an eco-friendly flowsheet to regenerate base and precious metals from waste printed circuits boards (WPCBs). Copper (as nanoparticles with an average diameter of 50 nm) and other base metals were extracted via oxidative acid leaching with high efficiency. Thiocyanate was employed for the first time as a green and economical reagent for the extraction of gold from pretreated WPCB. The effect of various parameters, including reagent dosage and temperature, was evaluated on the gold leaching rate, and 100% gold dissolution was achieved at the optimal condition. Also, at temperatures above room temperature, the recovery rate increases in a short period and then decreases continuously. The activation energy of the optimum gold thiocyanate leaching was found to be 42.84 kJ/mol, indicating chemical reaction to be the rate-controlling step. Gold extraction from the thiocyanate medium was carried out by employing activated carbon, where 100% gold adsorption was achieved in 2 h. Toxicity assessment of final residue revealed that it could be categorized as an environmentally safe waste with negligible risk.

2:45 pm

Valorization of Sulfide Flotation Tailing for Zn and Mn Recovery Using Acid Leaching and Solvent Extraction

W. Liu[1], H. Paine[2] and X. Yang[1]; [1]University of Utah, Blacksburg, VA and [2]University of Utah, Salt Lake City, UT

In this study, extraction and separation of valuable metals (Zn and Mn) from sulfide flotation tailing was investigated by conducting acid leaching and solvent extraction (SX) tests. Parameter leaching tests were conducted to investigate the leaching characteristics of the valuable metals and other contaminants. SX tests were performed to separate Zn and Mn from the 1.0 M H_2SO_4 leachate. Results show that the tailing contained 8.8% Mn and 1.9% Zn. Mn mainly existed as Mn-Fe carbonates, with the incorporation of Zn as a minor component. The carbonate nature favored the leaching process, with approximately 90% of Mn and Zn can be readily leached by 1.0 M HCl or H_2SO_4 with S/L = 100 g/L and 75 °C. Higher S/L ratios (>100 g/L) reduced the extraction of 1 M H_2SO_4 leaching due to gypsum passivation. After removing Al^{3+} and Fe^{3+} from the 1.0 M H_2SO_4 leachate by raising pH to 5.0 using NaOH, Zn was first isolated from the leachate via SX using a mixed solvent (i.e., 5% DEHPA and 5% Cyanex 272), followed by Mn extraction from the Zn-removed raffinate using 0.5 M DEHPA. The process proposed in this study could provide a pathway for tailings valorization.

3:05 pm

Leaching Kinetics of Glycine-H_2O_2 System for Selective Recovery of Lithium from LFP Cathode Materials

J. Lee[1], H. Jung[1], H. Kim[1], J. Ahn[2] and J. Ahn[1]; [1]Jeonbuk National University, Jeonju, Korea (the Republic of) and [2]Daejin University, Pocheon, Korea (the Republic of)

Leaching kinetic using glycine and hydrogen peroxide (H_2O_2) was investigated for selective recovery of lithium from LFP cathode materials. The concentration of glycine and H_2O_2 between 0.5 M and 2 M were tested in the pH range from 6 to 9 at 25°C. Then, various leaching temperatures from 25°C to 80°C were tested to investigate leaching mechanism. Results showed that 99.9% Li was leached with Li selectivity of 93.9% using 1.5 M glycine and 1.0 M H_2O_2. Also, the activation energy was 1.82 kJ/mol, and the leach reaction was classified to mass transfer controlled mechanism.

3:25 pm

Reutilization of the Process Water from LIBs Recycle Stream as a Chemical Reagent in the Synergistic Extraction and Recovery of Critical Metals

P. Lin, G. Rickauer and L. Pan; Michigan Technological University, Houghton, MI

The process water produced aside from recycling of spent lithium-ion batteries (LIBs) contains 1-2 g/L lithium (Li) together with phosphorous (P) and fluorine (F). Its disposal has raised the concern about losing potential valuables into the waste stream, as well as releasing unremoved F into the environment. This study evaluates the feasibility of reutilizing the anode process water as both a Li-containing source and a neutralizing reagent in the selective recovery of critical metals from waste LIBs. Potentially hazardous components were isolated by thermal treatment, followed by fluorine fixation. Affecting parameters, such as temperatures, chemical dosages, solution pH, and reaction time, were investigated to achieve >99% removal efficiency of hazardous components. Further research on using treated anode process water as the neutralizing reagent has proved it to be a promising alternative by lowering the valuable loss down to 10%. Lastly, Li_2CO_3 was recovered from mixed PLS and process water, with a purity above 99.5% (metal-basis). Characterization, including XRD, FT-IR, SEM-EDS, etc., was performed to facilitate the understanding of the precipitation mechanism.

3:45 pm

Alkaline Roasting and Leaching of Copper Slag Flotation Tails to Recover Critical and Valuable Elements (i.e., Ga, Ge, Mo)

E. Oteng, M. Silwamba, N. Bolorchimeg, M. Moats, A. Luyima, J. Smith and L. Alagha; Missouri University of Science and Technology, Rolla, MO

Gallium (Ga), germanium (Ge), and molybdenum (Mo) are essential elements widely used in advanced technological and industrial fields. This study investigated the recovery of Ga, Ge, and Mo from copper slag flotation tails through roasting with sodium hydroxide (NaOH) and subsequent leaching. The effect of various process parameters was investigated, including NaOH-to-slag ratio, roasting temperature, roasting time, NaOH concentration, and leaching temperature. Results showed more than 90% recovery of Ga, Ge, and Mo in the leachate. These results indicated that these critical and valuable elements can be recovered from copper slag flotation tails, supporting sustainable production and addressing rising demand. Keywords: gallium, germanium, molybdenum, roasting, leaching, critical elements, copper slag flotation tails.

4:05 pm

Selective Gold Extraction From Printed Circuit Boards Using A Potassium Ferricyanide Based Compound

J. Pearlman; Colorado School of Mines, Golden, CO

The circular economy has become a hot topic in today's industry, and one opportunity that many are focusing on in this regard is the electronics industry as many precious metals are utilized and the monetary density of electronics can be quite high. Extracting gold from electronics poses some challenges as cyanidation is toxic and also extracts copper, which is more common in electronics then gold and notoriously difficult to separate from gold. Authors have researched the capabilities of a potassium ferricyanide based compound that, at ideal conditions, has been shown to extract 99% of the gold from a printed circuit board (PCB) in under 5 minutes. This compound has several advantages over cyanide including its low toxicity (1-2% that of cyanide), alkaline nature that make pH adjustment unnecessary, and higher selectivity of gold over copper. Gold is targeted first by the compound, but after most of the gold has been dissolved, the compound moves on to copper and other metals on the PCB. The ideal process for gold extraction so far has been heating the solution to 30°C, a lixiviant concentration of 5%, and stirring the solution with the PCB suspended.

Tuesday, February 24
Afternoon

MPD: FLOTATION: CHALLENGES IN COMPLEX FLOTATION CIRCUITS

155F

Chairs: ***K. Huang****, Michigan Tech, Houghton, MI*
M. Lancaster*, Syensqo, Stamford, CT*

2:00 pm

Introductions

2:05 pm

Reprocessing a North American Zinc Tailing by Flotation: The Expected and Unexpected

F. Yang, E. Spiller and E. Holley; Colorado School of Mines, Golden, CO

Tailings have become a promising resource for critical minerals. In this study, zinc tailings were reprocessed using flotation to evaluate the recoverability of zinc. Two types of samples were examined: two drill-core samples collected at depth, representing older tailings, and fifty-three surface samples collected across the tailing storage facility (TSF), representing newer tailings. All samples were first subjected to elemental and mineralogical characterization. Flotation studies were then carried out separately on both sample types. Six-cleaner flotation processes were developed, with marketable concentrates produced. For beach samples, a recoverability variation study and a regrinding study was also conducted. Throughout the flotation studies, the floatability of minerals in the tailing and their responses to flotation reagents were evaluated, comparing the tailing with primary ores, also between the two types. These comparisons highlighted both expected and unexpected behaviors, revealing key characteristics of the tailings. The findings provide valuable insights into the general flotation behavior of tailings and can inform future strategies for tailing reprocessing.

2:25 pm

Improving Flotation Efficiency in Clay-Rich Mineral Systems

O. Onel and M. Hoang; Ecolab/ Nalco Water, Naperville, IL

Clay minerals pose significant challenges in flotation, affecting pulp rheology, surface chemistry, and froth behavior. Swelling clays, such as montmorillonite, increase viscosity, while non-swelling clays, like kaolinite and muscovite, cause sliming, entrainment, and froth instability. This study evaluates a novel reagent developed to mitigate these effects, particularly targeting non-swelling clays. Synthetic systems with chalcopyrite and individual clay types were tested for zeta potential and rheological behavior. Improvements were most notable in kaolinite- and muscovite-rich slurries, with enhanced dispersion, lower yield stress, and reduced surface slime. Bench flotation trials on various ore samples confirmed gains in copper recovery and selectivity. Though the effect on swelling clays was less pronounced, the chemistry showed strong robustness under mixed-clay conditions. These findings support the use of tailored dispersant strategies to manage diverse clay-related challenges in flotation circuits, offering a practical solution to improve performance in high-clay ore environments.

2:45 pm

Novel Collectors for Enhanced Precious Metal Recovery in Complex Polymetallic Ores

O. Yavuzkan[1], N. Botha[2], P. Zarate[1], A. Dehghani[2], P. Dopico[1] and W. Da Silva[1]; [1]Clariant, Wilton, CT and [2]SGS Canada, Lakefield, ON, Canada

Extracting the full value from polymetallic ores that contain Cu, Pb, Zn and economically vital Au and Ag —demands innovative approaches to overcome their intricate mineralogy. These ores challenge flotation processes, as precious metals are dispersed across multiple sulfide phases, requiring precise collector chemistry to boost recovery without sacrificing base metal recoveries and selectivity. Partnering with SGS Lakefield, we tested these reagents on a North American polymetallic ore featuring a complex sulfide mix: pyrite, sphalerite, galena, argentiferous galena, chalcopyrite, tetrahedrite, and covellite. Ag resides primarily in tetrahedrite and argentiferous galena, while Au appears as sub-micron native particles and fine inclusions within Pb and Cu —combinations that defy conventional flotation methods. Compared to commercial alternatives, Clariant's collectors excelled in laboratory trials, delivering: higher Au and Ag recoveries, better rejection of Zn and Fe sulphides and maintained Cu and Pb circuit efficiency. By targeting these mineral associations, the approach unlocks more value from complex polymetallic ores while balancing precious-metal gains with overall metallurgy.

3:05 pm

Froth Management in Cu/Mo Separations

M. Lancaster, C. McMillan and E. Arinaitwe; Syensqo, Stamford, CT

Cu/Mo separation circuits often deal with voluminous and persistent froth that reduces thickener efficiency, causes overflowing cells, and inhibits effective mineral separation. This presentation will discuss key challenges in managing non-ideal frothing behavior during Cu/Mo separations arising from bulk and Mo circuit reagent usage, operating conditions, and flowsheet configuration. Focus will be placed on chemical strategies to address Mo plant overfrothing including novel frothers, depressants, and defoamers. The development of a new, non-hazardous defoamer product will also be highlighted through lab-based characterization of bulk concentrate froth heights and flotation testing on Cu/Mo bulk concentrate samples from North and South American operations.

3:25 pm

Optimization of Sulphide Flotation at Pueblo Viejo Gold Mine via Glycol-Enhanced Frother Application

H. Reilly[2], B. Calienes[1], N. Mhonde[1] and G. Ventura[2]; [1]Nalco Water, Warrenville, IL and [2]Barrick, Pueblo Viejo, Dominican Republic

Pueblo Viejo gold mine faced significant challenges in maintaining froth bed stability during the startup of flotation processing. The existing frother, Methyl Isobutyl Carbinol (MIBC), has proven inadequate with increased sulphide grade and subsequent higher Potassium Amyl Xanthate (PAX) collector dosages, leading to froth bed collapse and resulting losses. Additionally, MIBC's weaker frothing properties necessitate higher dosages, resulting in emulsification of flotation cells, inefficient froth-pulp separation, and increased operational costs. Barrick partnered with NALCO Water to conduct a plant trial of an alternative frother (F181-13), an alcohol-based compound with added glycol ether, as it demonstrated enhanced froth stability and lower volatility compared to MIBC. The trial, involved optimizing the glycol percentage in a blend of 182-13 and MIBC, followed by a preblended frother (F181-13). This resulted in improved froth stability, overall increases in sulfide and gold recovery as well as a reduction in frother dosage.

3:45 pm

Evaluating Different Flotation Reagents to Enhance Battery-Grade Spodumene Concentrate Production

B. Cook, M. Aghamirian, S. Pedraza and H. Walqui; Metallurgy, Belmont, NC

Spodumene concentrates are typically produced through dense media separation (DMS) and/or froth flotation and are the leading source of lithium for the growing lithium-battery market. While DMS faces its own unique set of challenges, spodumene flotation can be particularly challenging due to the similar surface properties of value and gangue minerals and the poor solubility and selectivity of tall oil fatty acid (TOFA) collectors. This study investigated the impacts and benefits of alternate mica collectors (amines), dispersant/depressants, spodumene collectors (fatty-acid based), and frothers in a pre-defined spodumene flotation flowsheet that included mica preflotation, alkaline scrubbing, and spodumene flotation.

4:05 pm

Comparison of WEMCO® and WEMCO® II Flotation Rows in a Copper Rougher-Scavenger Application

I. Coltrin[1], B. Forbes[2], T. Sok[2] and D. Lelinski[1]; [1]FLSmidth and Co A/S, Valby, Denmark and [2]FLSmidth, Midvale, UT

The current WEMCO® flotation technology operates on a design that has not been updated since 1968. Since then, several advancements have been developed in flotation technology, including the nextSTEP™ flotation machine. The key features linked to the improved performance in the nextSTEP™ flotation machine have been applied to, or provided inspiration, for the next generation of WEMCO® flotation technology, the WEMCO® II flotation machine. The development and features of the WEMCO® II flotation machine are discussed along with a review of a previous cell-to-cell comparison which demonstrated improved airflow, froth stability, transport and retention, and recovery in a copper rougher application. This study expands on the previous study by performing a row-to-row comparison of nine 250m^3 cells of WEMCO® to comparable WEMCO® II flotation cells in a copper rougher-scavenger application. Results are detailed as improved airflow, froth stability, transport and retention, and improved copper recovery of row of WEMCO® II flotation cells.

4:25 pm

Designing a Simplified Cleaner Circuit with a Concorde Cell for a Future Copper Concentrator

M. Durán[1], A. Yáñez[2], R. Dube[3], V. Concha[3] and C. Hernández[4]; [1]Metallurgist, Pori, Finland; [2]Senior Manager, Espoo, Finland; [3]Technology Manager, Espoo, Finland and [4]Process Engineer, Santiago, Chile

The Concorde Cell is a high-intensity pneumatic flotation technology dedicated to fines and ultrafines. This case study presents the potential of integrating Concorde Cell into a conventional circuit as evaluated through pilot plant testwork. As a cleaner scalper, the Concorde Cell produced from a 2.8% Cu feed grade concentrates of 25 to 28% for stage recoveries of 60 to 80%. As a recleaner of the cleaner scavenger mechanical cells, it produced a final concentrate grade at 90% stage recovery. Simulations demonstrate that the cleaner circuit can generate 25% Cu grade at 95.5% stage recovery.

Tuesday, February 24 Afternoon

MPD: FLOTATION: COARSE PARTICLE FLOTATION

155C

Chairs: ***R. Dube****, Metso USA, Centennial, CO*
Z. Zanetell*, Newmont, Castle Rock, CO*

2:00 pm

Introductions

2:05 pm

26-024

Coarse Particle Flotation – New Solutions for an Old Challenge

M. Nelson[1], R. Dunne[3] and A. Richins[2]; [1]Stantec, Salt Lake City, UT; [2]Weir Minerals, Salt Lake City, UT and [3]Consultant, Perth, WA, Australia

Recovery of coarse particles has been an ongoing challenge. By the early 1900s, flotation processes included oil flotation, skin flotation, agglomeration flotation, and froth flotation, and for each there was a proliferation of flotation equipment. But from the start, recovering coarse particles was difficult. Froth flotation was at first used for finer materials from grinding circuits, and for years the maximum size for coarse particle flotation was 3.18 to 4.78 mm, depending on the specific gravity of the particles. Coal and other low density, flaky minerals like mica can be froth-floated in larger sizes. In the early 1960s, the phosphate industry began using column cells to float coarse particles, but early columns suffered from poor bubble generation and sanding at the base of the column. Better coarse particle recovery has been the recent object of new cell designs—the Eriez HydroFloat, Jord NovaCell™, FLS coarseAir™, and Cidra P29 integrated system. The paper will examine recent developments in coarse particle flotation, focusing on the development, testing, and operation of the new flotation technology designed to recover coarse particles.

2:25 pm

Metallurgical Performance of a New Coarse Particle Flotation Technology in its First Industrial Trial in a Copper Concentrator

C. Emer[1], M. Carvalho[2], N. Kupka[2], R. Dube[3] and A. Rinne[2]; [1]Metso Turkiye, Ankara, Turkey; [2]Metso Finland, Espoo, Finland and [3]Metso USA, Denver, CO

Metso has developed and launched a new Coarse Particle Flotation technology at the end of 2025. This pneumatic flotation cell relies on slurry fed on top of a deep froth for effective separation of even the least liberated particles. A demonstration plant with a capacity of 22 to 28 tonne per hour including this cell was installed in a copper concentrator in Chile in a final tail scavenging duty. The metallurgical performance at industrial scale depending on operating conditions will be presented.

2:45 pm

Extending the Particle Size Limits of Flotation Using Acceleration Forces

J. Leland, A. Srinivasan, M. Gupta, K. Huang, A. Noble and R. Yoon; Virginia Tech, Blacksburg, VA

Flotation is efficient over a narrow particle size range of ~20-150 μm, causing problems in recovering fine and coarse particles. The authors developed jig flotation cells that can improve the recovery of coarse particles, which can be attributed to the jigging mechanisms that prevent particles from reaching terminal velocities and hence reduce the detachment force. It has also been found that the jig flotation cell significantly improves the flotation of ultrafine particles, as the acceleration forces help particles overcome the strong hydrodynamic resistance in bubble-particle interactions. Pilot-scale jig flotation tests conducted on copper ore samples showed encouraging results in extending the flotation limits.

3:05 pm

HydroFloat™ Modeling of Fluidized Bed Combined with Historical Data Analysis Model for Copper Application

R. Rodrigues Silva, J. Concha and H. Fayed; Eriez, The Woodlands, TX

This study evaluates the integration of two models to assess the performance of HydroFloat. The first model predicts the porosity and apparent density of the fluidized bed under specific operational conditions, which include teeter water flow rate, air flow rate, bed height, pressure settings, and the characteristics of the feed ore, such as specific gravity and particle size. Furthermore, this model can predict the HydroFloat™ settings needed to achieve the desired fluidized bed porosity for any given ore. The second model encompasses a series of HydroFloat pilot test results, consisting of 80 data points gathered from various copper plants and applications, which were analyzed using Design-Expert software within a historical data analysis framework. This analysis resulted in a metallurgical model that incorporates variables like superficial air rate, superficial teeter water rate, freeboard, and bed height. By integrating both models, a unique framework is established that aims to optimize HydroFloat conditions for enhanced metallurgical performance.

3:25 pm

Pilot Test Campaign Results on Coarse Feldspar Flotation Using Novel coarseAIR™ Flotation Technology

G. Lusty, L. Christodoulou, J. Bowden and H. Patel; Member, Sandy, UT

Traditionally, conventional froth flotation struggles with floating coarse particles. Which leads to losses in recovery, or a comminution bottleneck trying to reduce particle size to get maximum grade and recovery. CoarseAIR™, a novel technology that integrates an aerated fluidized bed with the hydrodynamic advantages of the REFLUX® Classifier, can float larger particles of target material while rejecting fine gangue. This paper is based on pilot testing done with coarse feldspar ore, detailing the optimized operational parameters to achieve improved grade and recovery. The coarseAIR™ pilot demonstrated results consistent with the lab findings and outperformed the plant.

3:45 pm

Coarse Particle Scavenging in a Modified Jameson Cell

C. Anderson; Senior Metallurgist - Jameson Innovation, Brisbane, QLD, Australia

Coarse particle flotation is gaining increasing popularity as means of coarsening the grind on an existing circuit and increasing the throughput. However, these circuits require significant water input, both for classification and fluidisation with an overwhelming capital cost which often strains the economic viability of the project. This paper demonstrates an alternative approach which removes the need for upfront classification, while still target recovering particles in the -425+300 micron range which were otherwise unrecoverable in the upstream circuit. The resulting circuit is drastically reduced in cost and is able to deliver a higher internal rate of return. This is demonstrated via a case study on Glencore's Tintaya concentrator, where a modified Jameson Cell was used to recover coarse particles from the final tails stream with a grade of Cu ~0.05%.

4:05 pm

HydroFloat® Pre-Rougher Application: An Opportunity to Reduce Grinding and Enhance Throughput

M. Elseyh and A. Luke; Eriez Manufacturing Co., Erie, PA

Chilean copper production faces challenges such as lower head grades, harder ores, water limitations, and energy constraints. Coarser grinding has become attractive, but conventional flotation struggles to recover coarse particles due to turbulence, buoyancy limits, froth inefficiencies, and poor liberation, causing losses in the +106 μm fraction. To address this, Eriez developed the HydroFloat® cell, combining flotation with hindered-settling to improve coarse particle recovery. Lab tests on fresh copper ores at different P80 sizes assessed HydroFloat® performance in a Coarse Gangue Rejection (CGR) or Pre Rougher setup. This split-circuit design sends fine material to conventional flotation and coarse to HydroFloat®. Results showed recovery of 106–600 μm particles with <10% liberation, achieving 67.7–87.3% copper recovery. The HydroFloat® concentrate is reground and floated to produce final product. This approach reduces grinding, boosts rougher-stage fines flotation, increases plant throughput, and ultimately copper production.

4:25 pm

Intensifying Fluorite Beneficiation Using Nanobubble Technology

A. Sobhy; Missouri S&T, Rolla, MO

Conventional fluorite beneficiation from quartz-rich ores (~55% CaF_2) demands high reagent and energy inputs, limiting economic and environmental sustainability. This study investigates nanobubble (NB) technology (<200 nm) as an intensification strategy for fluorite flotation in mechanical and column cells through enhanced interfacial interactions. Systematic optimization of sodium oleate (collector), sodium silicate (depressant), and MIBC (frother) dosages was performed alongside hydrodynamic parameter control (superficial air/wash water velocity and NB generator slurry flow rate), yielded significant improvements: NB integration in mechanical cells reduced collector and depressant consumption by over 50% while maintaining >90% CaF_2 grade at 80% recovery; In column cells, NB synergy improved recovery by an absolute 7.20% vs. baseline at equivalent grade (>90% CaF_2). These enhancement are attributed to NB-induced improvements in particle-bubble adhesion kinetics and reduced hydrodynamic detachment forces, enabling sustainable fluorite processing via simultaneous reagent reduction and recovery intensification. Keywords: Nanobubbles; Fluorite; Reagent Reduction; Column Flotation.

Tuesday, February 24 Afternoon

MPD: PHYSICAL SEPARATIONS: PHYSICAL SEPARATIONS

155D

2:00 pm • Tuesday, February 24

Chairs: ***M. Archanbo****, Weir*
T. Ogunsunlade*, Penn State*

2:00 pm

Inroductions

2:05 pm

Feasibility of Gravity Concentration on Gallium and Germanium-Bearing Zinc Tailings: Implications for Flotation Performance

H. Aytac, F. Nakhaei and L. Alagha; Missouri University of Science and Technology, Rolla, MO

Gallium (Ga) and Germanium (Ge) are classified as critical elements due to their essential roles in advanced technologies and their limited primary supply. Recent studies have revealed that fine tailings from the Tri-State Mining District Superfund Site host Ga and Ge in association with zinc minerals. These critical elements typically occur through elemental substitution or inclusion within zinc minerals such as sphalerite (ZnS), hemimorphite ($Zn_4Si_2O_7(OH)_2.H_2O$), and smithsonite ($ZnCO_3$). This study systematically evaluated the effect of preconcentration of bulk tailings using a shaking table on the subsequent flotation recovery and grade of Ga and Ge. Mineralogical, elemental, and particle size analyses were conducted to identify the zinc mineral phases and their distribution in both the shaking table fractions and flotation concentrates.

2:25 pm

Investigation of Physical Separation Methods for the Recovery of Rare Earth Elements from Kennecott Mine Tailings

M. Guenther[1], M. Brevig[2], J. Gillow[2] and S. Ulrich[2]; [1]Rio Tinto, South Jordan, UT and [2]Arcadis, Highlands Ranch, CO

Rare Earth Elements (REE) are elevated in some rock types at the Kennecott Copper Mine near Salt Lake City, Utah. Previous work determined that a vast majority of REEs deport to tailings during processing. To explore the potential for REE recovery from these tailings, proof-of-concept bench testing was conducted on two tailings streams from the Kennecott concentrator. Various physical beneficiation methods, including magnetic separation, gravity separation, and flotation were used. Flotation proved to be the most effective. Testing results are presented, along with implications for further REE recovery.

2:45 pm

Hydrocyclone Classification, Maintenance, and Operational Improvements at Montana Resources

P. Keyser[1], J. Bentley[2] and A. Richins[1]; [1]Weir, Salt Lake City, UT and [2]Montana Resources, Butte, MT

Montana Resources, LLC desired to improve the overall performance of the rod mill/ball mill grinding circuit. By improving classification efficiency and designing for spare capacity, CAVEX® hydrocyclones resulted in lower fines bypass to the hydrocyclone underflow and reduced coarse solids to the overflow. This resulted in the elimination downtime attributable to the hydrocyclones, reduced maintenance expenses, and downstream benefits. Over the course of the initial six-month test period, Weir worked collaboratively with Montana Resources personnel and installed and operated CAVEX® Model 700CVX hydrocyclones, fitted with Weir NEXT intelligent solutions, on a single grinding line for the trial period. Results indicated that the goals of the trial were obtained. As a result, the remaining grinding lines were retrofitted with CAVEX® hydrocyclones. Benefits included a marked decrease in hydrocyclone wear and, due to improved classification, an increase in flotation recovery.

3:05 pm

Physical Separation and Characterization of Micrometeorites from Belle Fourche Shale

J. Kellar, A. Helgert, S. Kessinger, N. Madden, F. Thompson and M. West; SD School of Mines and Technology, Rapid City, SD

The Earth is continually showered with micrometeorites (MMs). In this study MMs were collected in fossilized form from Belle Fourche Shale (BFS). BFS was comminuted (hammer mill) to liberate individual particles, slurried, and separated into magnetic/non-magnetic fractions using wet high intensity magnetic separation (WHIMS). The magnetic particles were classified by size, and a stereomicroscope was used to identify (based upon sphericity) potential MMs. This physical separation resulted in a flux of 40 MM prospects in 26.4 kg of BFS. Potential MMs were next analyzed with a scanning electron microscope (SEM). The SEM allowed high resolution and imaging as well as energy dispersive x-ray spectroscopy (EDS). Further characterization of potential MMs was performed using a focused ion beam (FIB) and a transmission electron microscope (TEM). EDS revealed that many of the MM prospects were composed of iron oxides (magnetite (Fe_3O_4) and wustite (FeO)) as well as iron silicates like olivine $(Mg, Fe)_2SiO_4$. Tungsten and tantalum-nickel based particles were also found, however further analysis of these prospects is needed to confirm their origin (anthropogenic or not).

3:25 pm

Improved Interpretation of Continuous Settling Tests for Copper Tailings

S. Li and I. Peterson; University of Utah, Salt Lake City, UT

Tailings dewatering through sedimentation is one of the most cost-effective solid–liquid separation processes in the mining industry. Continuous or dynamic settling tests are widely used in laboratories to evaluate the sedimentation behavior of tailings and provide essential inputs for thickening design. However, despite the availability of various experimental setups, standardized testing procedures remain lacking. Furthermore, test results are often interpreted using theories and models originally developed for batch settling, such as Kynch theory, which may not fully capture the complexities of real tailings suspensions. This study presents an experimental investigation on copper tailings and examines the influence of differential settling behavior on the dewatering process. New approaches are proposed to interpret continuous settling test results, offering improved insights and predictive capabilities for optimizing tailings dewatering operations. The findings have the potential to enhance the design of tailings thickening systems in mining practice.

3:45 pm

Recovery of Aluminum from Landfiils via Landfill Mining and Physical Separation Techniques

D. Amponsah-Berko; Michigan Technological University, Houghton, MI

This study investigates the recovery of aluminum scrap from municipal solid waste (MSW) landfills through landfill mining and dry separation technologies. Coarse fractions (>7 mm) from the Marquette County Solid Waste Management Authority landfill were hand-sorted to assess material composition, while fine fractions (<7 mm) were processed using a pilot-scale aerodynamic separator. A simulated landfill experiment was also conducted to evaluate long-term aluminum degradation; the simulation experiment reveals 50% corrosion of aluminum foil after six months. Results demonstrate the potential of recovering high-purity aluminum from legacy waste streams, offering a low-energy alternative to primary production and supporting circular economy initiatives.

4:05 pm

26-043

Optimal Design and Digital Prototyping of E-volute and E-duc Feedwell System

Y. Lu, T. Sok, J. Scott and C. Gilbert; FLSmidth, Midvake, UT

Feedwell design is critical for efficient solid–liquid separation in gravity thickeners, as it governs hydraulics, dilution, and flocculation. This paper presents an optimized design and digital prototyping approach for FLS's E-volute and E-Duc Feedwell system, integrating advanced computational fluid dynamics (CFD) with functional requirements and evaluation criteria introduced at SME2024. Building on FLS's proven technologies, several new configurations were developed and evaluated under full-scale, real-world conditions. CFD simulations provided detailed visualization and quantification of flow distribution, dilution effectiveness, and flocculation processes, guiding iterative refinement. The resulting design achieved superior hydraulic performance, enhanced mixing efficiency, and improved flocculation. Beyond the optimized feedwell solution, this study demonstrates CFD as an effective and economical tool for digital prototyping, enabling early identification of design limitations, reducing reliance on physical trials, and accelerating innovation. The methodology highlights the value of simulation-driven design in advancing thickener performance and mineral processing practice.

Tuesday, February 24 Afternoon

MPD: PLANT DESIGN: PANEL SESSION - COMMISSIONING

Grand Blrm D

Chair: ***J. Wickens****, McClelland Labs, Sparks, NV*

2:00 pm

Introductions

2:05 pm

MPD Plant Design Panel Discussion, 2026, Commissioning/Start-Up/Ramp-Up

J. Wickens; Wickens Process Services LLC, Sparks, NV

This Panel Discussion is the last in a three-part series covering the different phases of project development. The 2024 and 2025 sessions covered Project Development, Detailed Engineering and Construction. This year's session will feature industry leaders with extensive commissioning, start-up and ramp-up experience. Panelists include John Marsden, Ed Macha, Andy Cole and Jose Martinez. The panel discussion will be moderated by Mike Spicher and features a series of "hot topic" questions posed to the panelists to share their insight and wisdom. Each panelist will have an opportunity to share their thoughts on each question, as well as field questions from the audience.

Tuesday, February 24 Afternoon

RESILIENT ENERGY IN MINING: BALANCING TRADITION AND TRANSFORMATION: OPPORTUNITIES AND CHALLENGES FOR THE MINING INDUSTRY TO LEVERAGE TECHNOLOGY AND PEOPLE TO DRIVE OPERATIONAL PERFORMANCE AND ESG IMPACTS

Grand Blrm B

Chair: ***A. Ashok Parmar****, Freeport McMoran inc, Tucson, AZ*

2:00 pm

Introductions

2:05 pm

Autonomous Drilling, Can Operator Assist Technologies Impact the Bottom Line?

C. Stacy; Hexagon Mining, Tucson, AZ

Autonomous drilling has been around for multiple decades, but are mines getting any value from the technology? Hexagon presents two case studies showing the most recent results of the technology in action in different mining conditions. The results will highlight how the use of the autonomous technology provides real, measurable value by increasing the equipment efficiency and solving the labor skill gap problem.

2:25 pm

How to use Natural Capital to Optimize Operations to Maximize Mine Profitability

B. Murphy and B. Cox; B-Squared Natural Capital, Beaverton, OR

Mining companies are facing increasing pressure to reduce resource consumption while meeting growing global demand for metals and minerals. Environmental and social performance has become a strategic priority, with investors expecting tangible results in these areas—alongside continued profitability. However, a disconnect often exists between Sustainability professionals, who are charged with identifying and executing improvement initiatives, and the mine-site Operational teams. This organizational siloing has led to the oversight of relatively low-investment opportunities that both reduce the mine's natural capital consumption and enhance operational profitability. This paper highlights practical examples of such opportunities and presents a structured approach to identifying and quantifying them so they can be implemented.

2:45 pm

Improved Bucket Design for Higher Efficiency and Reducing Carbon Footprint

A. Ur Rehman, S. Hyde and A. Hernandez; Weir ESCO, Portland, OR

Global trends towards electrification to accelerate decarbonization has also increases the demand outlook on metals extraction from the mining industry. Decarbonization will require miners to continuously maximize the energy efficiency by improved production processes. The mining challenge is to provide more material and reduce emissions emanating from the operation. Buckets are integral part of loading equipment and designing excavator buckets that reduces energy consumption can help companies successfully reduce scope 1 emissions. The study compares various bucket designs and prototypes for 300 to 800 t class machines, with analysis that details bucket performance based on mass loaded per joule of energy. The extensive design of experiment approach includes various bucket geometric features and components resulting in an optimized design suited for mining operation. The optimized design of bucket is further analyzed to estimated payload gathered, energy consumed and overall fuel burnt per ton of ore mined for diesel engine based shovels. The results show how rigorous design of buckets can help reduce emissions from mine & can help mines in achieving their sustainability targets.

3:05 pm

Resilient Energy Solutions for Mining: Unlocking Operational Stability and Sustainability

S. Zope; Worley Group Inc.

Mining operations face chronic inefficiencies that hinder energy performance, increase O&M costs and limit production potential. These issues, often normalized within operations, can be rapidly resolved to drive energy resilience and process stability. Drawing on Worley's project experience across US and Americas mining assets, this paper outlines how targeted operational interventions, combined with advanced Engineering and digital tools, improve energy efficiency, reduce consumables and enhance metal recovery. The approach enables mines to process variable ore types, reduce capex during expansions and achieve record production within months. This paper offers a practical roadmap for mining operations to transition towards resilient, low-carbon and high-efficiency systems.

3:45 pm

Redefining Sustainble Copper Mining: Florence Copper & In-Situ Copper Recovery

S. Dessart; SME Member, Florence, AZ

Located in the Town of Florence, Arizona, Florence Copper is a first-of-its-kind, greenfield in-situ copper recovery (ISCR) project that is redefining the copper industry. Eliminating the need for large-scale open-pit or underground excavation, waste rock piles, and tailings storage facilities, Florence Copper's ISCR operation is projected to be the lowest greenhouse gas and energy-intensive copper producer in North America. The project also will be the first U.S. copper mine to enter commercial operations in over a decade. This presentation will provide an overview of the project's ISCR process, status, and benefits for the mining industry and the nation.

Tuesday, February 24
Afternoon

TAILINGS MANAGEMENT: CLOSURE - DOES "SAFE" = "DRY"?

Sponsored by Newmont

155B

Chairs: ***K. Desai****, Mosaic, Lithia, FL*
R. Dorow*, Stantec, Aurora, CO*

2:00 pm

Introductions

2:05 pm

How Can We Characterize Legacy Tailings for GISTM? A Case Study

S. Sun, P. Crouse and R. Dorow; Stantec, Potomac, MD

As part of a broader effort to align with the Global Industry Standard on Tailings Management (GISTM), legacy tailings piles at Holden Mine were characterized using a grouped testing approach grounded in Critical State Soil Mechanics (CSSM). Given the heterogeneity of the tailings and the incomplete historical records, the materials were first grouped based on depositional patterns, visual stratigraphy, and preliminary index properties. Representative samples from each group were subjected to geotechnical laboratory testing, including particle size distribution, specific gravity, Atterberg limits, and triaxial shear testing, to assess strength and deformation characteristics under different loading conditions. The CSSM framework was used to evaluate the contractive or dilative tendencies of the tailings, providing insight into potential failure modes and liquefaction susceptibility. This grouped characterization approach allowed the project team to efficiently assess spatial variability within the pile while generating the data needed to support risk-informed decisions in line with the GISTM's technical and ethical expectations.

2:25 pm

Pilot Test Application of Amprey™ and Misty CO_2™ Water Treatment at Faro Mine, Yukon Territories

R. Stephenson[1], N. Finke[2], A. Herchak[1] and M. Bianchin[2]; [1]waterStrider Treatment Inc., Vacouver, BC, Canada and [2]RESPEC Canada Inc., Vancouver, BC, Canada

Amprey™ is an electrochemical technology that removes dissolved selenium from mine-impacted water by generating Fe^{2+} throughfrom steel pellet anodes,. Fe^{2+} consumes dissolved oxygen, thus creating reducing conditions that convert selenate into reactive forms of selenium that co-precipitate with iron to form stable solids. Misty CO_2™ complements thisAmprey™ by lowering pH via in situ carbonic acid formation, using CO_2 and alkaline water—eliminating the need for mineral acids, reducing GHG emissions, and improving safety. Integrated with a Redox Reactor and Misty™ for pH control, the system achieves sub-ppb selenium removal and targets co-contaminants likeincluding uranium, arsenic, sulphate, and nitrate. At Faro Mine in Yukon, the technology is being considered as an interim measure to meet compliance under updated, more stringent regulatory limits. Full-scale deployment (>30,000 m^3/d) will demonstrate long-term performance under Arctic conditions. These technologies reduce CAPEX/OPEX risks and diesel reliance on imported chemicals, while delivering high contaminant removal efficiency. and non-leachable solids. Pilot trial results will be presented.

2:45 pm

Potential for Hydrus 1D to be Used to Model Oxygen Transport in Multilayer Covers with Capillary Break Effect (CCBE)

D. Sims; Norda Stelo, Roxboro, QC, Canada

Covers with capillary barrier effects (CCBE) are used throughout mining and other sectors to minimize oxygen in waste material such as reactive mine tailings. The goal is to minimize the oxidation of sulfides and the production of acidic environments in the tailings conducive to metal mobilization. Modeling techniques were developed to assess the oxygen flux through a barrier cover to optimize the thickness and costs of materials required for a tailings cover. Initial results show promise that needs further research and calibration. The modeling software Hydrus-1D was utilized to determine the reduction of oxygen within the CCBE.

3:05 pm

Constraining Recharge to TSFs via Model Calibration to Transient Evaporation and Soil Moisture Data

A. Wunsch, A. Mohamed, P. Tullius and K. Williams; SRK Worldwide, Vancouver, BC, Canada

Estimates of recharge to tailings storage facilities (TSFs) are necessary for long-term TSF closure and management. These estimates inform pore pressure responses and seepage from these facilities to the underlying groundwater system. However, recharge estimates are typically highly uncertain due to absence of transient field observations. In addition, direct measurement of TSF hydraulic properties is difficult: In-situ testing methods are limited, and laboratory methods suffer bias from sample handing. This work describes calibration of a 1D infiltration model to eddy covariance (E.C.) tower and soil moisture probe data at a closed TSF in the southwest USA. Model boundary conditions were refined using potential evaporation and precipitation data from the E.C. tower. Uncertainty in model parameters was reduced by employing an iterative ensemble smoother (IES) calibration method to transient field observations. This provided a range of plausible model parameters that would result in reasonable calibration, or an ensemble of models that reasonably describe hydraulic processes. Thus, accounting for potential non-uniqueness in model construction and parameterization.

3:25 pm

Phosphogypsum Stack Closure: Practical Advances and Lessons Learned

A. Riad and M. Al-hawaree; Ardaman & Associates, Inc., Orlando, FL

Phosphogypsum is a by-product of the production of phosphoric acid from phosphate rock. Phosphogypsum is stored within Phosphogypsum Stacks that occupies large areas within industrial facilities. Closing phosphogypsum stacks includes complex engineering and must balance environmental protection, regulatory compliance, and long-term performance. We have delivered closure solutions across the globe, ranging from steep side-slope systems to closure incorporating phased strategies and "smart closures". Each project begins with a comprehensive assessment of stack conditions and historical development, followed by a closure design for a stack cover system that control infiltration, erosion, and slope stability. Designs also incorporate stormwater routing, toe drains, stack-top closure, long-term draining and process water handling and maintenance and monitoring of the stack closure design, and adaptable to active operations, and streamlined for regulatory approval. This presentation will highlight phosphogypsum stack closure development over the years, key lessons learned, innovative design strategies, and real-world examples from our extensive portfolio of phosphogypsum stack closures.

3:45 pm

26-055

Safe Closure of Tailings Storage Facilities: Application of GISTM for Responsible Management

G. Toledo; Arcadis, Santiago, Santiago, Chile

The closure of tailings storage facilities (TSFs) is a critical stage in the mining cycle that requires the integration of technical, environmental, and social dimensions to ensure long-term safety and sustainability. The GISTM defines "safe closure" as a demonstrable technical condition, with no material risks to people or the environment, validated by an independent reviewer and approved by the Accountable Executive. This article presents a risk-based methodology aligned with the GISTM, which addresses the progressive management of risks from design through to post-closure monitoring. It integrates key elements such as robust knowledge bases, climate change, credible failure modes, continuous monitoring, stakeholder engagement, and governance. It applies the ALARP principle to demonstrate that residual risks have been reduced to tolerable levels. The proposed approach aims to contribute to responsible and verifiable closures, in accordance with standards such as ANCOLD and ICOLD. Keywords: Safe Closure, TSF, GISTM, ALARP, Risk Management, Mine Closure.

4:05 pm

Panel Discussion After Presentations (if time allows)

Wednesday, February 25 Morning

BULK MATERIAL HANDLING: INNOVATIVE TECHNOLOGIES

155A

Chair: ***T. Hollingsworth****, FLSmidth, Meridian, ID*

9:00 am

Introductions

9:05 am

Advanced Simulation and AI-Driven Shovel-Truck Dispatching for Dynamic Mine Operations

A. Maremi, T. Boakye and E. Bakhtavar; Laurentian University, Sudbury, ON, Canada

Materials handling represents about 60% of total mining costs, emphasizing the critical need to optimize mining operations. Traditionally, mine planning and equipment management have been treated separately due to the increased complexity and computational demands of integrated models. This separation often results in suboptimal fleet allocation and dispatching decisions that do not align with short-term operational plans or support sustainable resource use. This research proposes a novel framework that integrates truck-shovel sizing, allocation, and dispatching with mine planning strategies to address geological and operational uncertainties. By leveraging advanced simulation and analytical tools, the study aims to improve resource utilization, productivity, and operational resilience. Expected outcomes include the development of a comprehensive simulation model that replicates dynamic mining environments and an intelligent mining agent that optimizes fleet operations. These tools are anticipated to enhance decision-making accuracy, reduce operational delays, and lower costs, ultimately contributing to more sustainable and efficient mining practices.

9:25 am

26-015

Conveyor Monitoring Through Fiber Optic Cables - Reducing Downtime, Increasing Safety and Improving Preventative Maintenance

M. Cook; Hawk Measrurement Systems, Nunawading, VIC, Australia

Technological developments in Distributed Fiber Optic Sensing and improvements in both hardware and software have allowed for fiber optic sensing systems to be deployed in a variety of applications such as pipeline leak detection, perimeter security monitoring and power cable real time thermal rating. Recently there has been a larger adoption of monitoring of conveyor belts in so called "Conveyor Health Monitoring Systems" within the mining and bunk material handling industries to identify idler conditions on an ongoing basis. This paper summarizes the application conditions and requirements, design considerations, methodologies used, the outcomes achieved, the logistical and field considerations and the future possibilities of the use of this technology in the Conveyor Health Monitoring Systems using Distributed Fiber Optic Sensing.

9:45 am

New Advancements in Conveyor Belt Rip Detection

S. Schurman; ICL America, Denver, CO

Early detection of conveyor belt damage is critical to avoiding costly downtime and catastrophic failures. Scanning systems identify steel cord damage, splice weaknesses, and potential rips before they worsen. These methods have been used for the last 50+ years, and we have been making significant improvements and are excited to explain the technology involved, as well as the numerous benefits. Our Rip Prevention+ system is the only rip detection technology that does not require embedded loops in the conveyor belt, making it easier to install and maintain. Popular throughout Europe and now gaining traction in the U.S., Rip Prevention+ monitors belts externally and alerts operators to developing rips in real time. Proactive diagnostics reduce unplanned stoppages, extend belt life, and improve safety. In high-production environments, even brief interruptions can result in major financial loss—making preventative technology a valuable investment. I feel this would be very interesting to anyone working in the mining industry, specifically with conveyor belts and conveyor belt maintenence.

10:05 am

26-025

Digital Drives for the Future: FLENDER ONE's AI-Powered Industrial Revolution

J. Reimann; Flender GmbH, Voerde, Germany

FLENDER ONE represents a paradigm shift in industrial gearbox technology, combining 125 years of mechanical expertise with cutting-edge digital innovation. This revolutionary platform eliminates the traditional 50% oversizing of industrial gearboxes through AI-driven engineering, while METAPERFORM® gearing technology reduces power loss by up to 50%, lowering operational costs. The integrated AIQ sensor technology enables predictive maintenance, reducing unplanned downtime by up to 70% and maintenance costs by up to 40%. With an intuitive online configurator requiring just three parameters, customers can design their perfect gearbox in minutes. This presentation demonstrates how FLENDER ONE transforms traditional manufacturing into Industry 4.0 reality.

10:25 am

26-022

Design Overview of Technogrid Conveyance Arresting System and Mounting Details in the Hermosa Headframe

Z. White[1] and C. Stephenson[2]; [1]Nordmin Engineering, Thunder Bay, ON, Canada and [2]Technogrid (Pty) Ltd, Kommetjie, South Africa

This paper presents the design approach case study for incorporating a Technogrid conveyance End-of Wind arresting system within the new South 32 Hermosa headframe. Focus is placed on energy absorption requirements, structural integration, and mounting details tailored to the geometry and operational constraints of the headframe. Key considerations include arresting forces, load path continuity, and connection design to ensure reliability and maintainability. The paper also discusses coordination with other headframe systems and the iterative design process used to meet safety standards and client objectives.

10:45 am

NIOSH-Developed Dustinator® Reduces Airborne Dust and Silica at Mine Sites

G. Bierie; Benetech USA, Aurora, IL

Worker exposures to RCS at mining sites are particularly high, likely due to the crushing, sizing, and handling of silica-bearing minerals [Misra et al. 2023]. NIOSH partnered with Benetech to create a new hybrid dust control system for use on belt conveyors and transfer points. The work included developing three subsystems that work together: (1) passive dust control, (2) active dust filtering, and (3) spray dust suppression. The subsystems were tested in the laboratory and then in the field. System testing demonstrated the effectiveness of enclosing the conveyors, crushers, and transfer point. Testing demonstrated a 93% decrease in respirable dust concentrations in air [Parks et al. 2024]. This research shows the potential for significant dust reduction by retrofitting material handling systems with a hybrid dust control system.

Wednesday, February 25
Morning

COAL & ENERGY: INNOVATIONS IN DUST CONTROL TECHNOLOGY & MANAGEMENT

151 D-F

Chairs: ***G. Xu****, Missouri University of Science and Technology, Rolla, MO*
R. bakzadeh*, University of Kentucky, Lexington, KY*

9:00 am

Introductions

9:05 am

Assessing the Role of Temperature and Time on the Efficiency of the 6 wt% rGO-PAN Filter in the Removal of 0.3 μm Respirable Silica Dust

M. Moradi, A. Kakoria and G. Xu; Missouri University of Science and Technology, Rolla, MO

This study evaluates polyacrylonitrile (PAN) nanofiber filters embedded with 6 wt% reduced graphene oxide (rGO) for removing respirable silica particles (0.2–0.3 μm). Experiments were conducted at 10°C, 20°C, and 35°C for exposure times of 1, 5, 15, and 30 minutes. Results revealed enhanced filtration efficiency and a moderate pressure drop with increasing temperature and duration. At 35°C and 30 minutes, efficiency reached 96% with a pressure drop below 200 Pa. The improved performance is attributed to elevated particle diffusivity and fiber-particle interactions. These findings suggest PAN-rGO filters are promising for respirable dust control in thermally dynamic mining environments.

9:25 am

Quantitative Application of Raman Spectroscopy in Measuring Crystalline Silica in Coal Dust

W. Feng[1], L. Zheng[2] and G. Xu[1]; [1]Missouri University of Science and Technology, Rolla, MO and [2]China University of Mining and Technology, Xuzhou, Jiangsu, China

Raman spectroscopy was explored for quantifying crystalline silica in coal dust samples using unary linear regression (ULR) and partial least squares regression (PLSR). Formulated samples with known silica content underwent ashing, dispersion, and deposition onto aluminum substrates. The ULR model yielded an R^2 of 0.90 with a detection limit (LOD) of 0.96% (19.17 μg), while the PLSR model achieved an R^2 of 0.988 and an LOD of 0.18% (3.65 μg). An improved PLSR model using samples from diverse geological origins showed strong agreement with standard infrared (IR) results, highlighting Raman spectroscopy's potential for accurate silica measurement in coal dust.

9:45 am

Development of a Light Scattering Method for Respirable Dust Mass Measurement Without Pre-Sampling Separation

C. Chen[1], L. Zheng[2] and G. Xu[1]; [1]Missouri University of Science and Technology, Rolla, MO and [2]china university of mining and technology, XuZhou, jiangsu, China

Monitoring respirable dust is vital for protecting workers' health and preventing occupational diseases Currently, respirable dust detection typically involves a two-step process of sampling and analysis, which is time-consuming and complex. This study proposes a rapid detection method for respirable dust that eliminates the need for front-end sampling. Leveraging the capability of light-scattering dust sensors to detect particle size distribution and the specific size range of respirable dust, two detection models were developed using multivariate linear regression and physical calculation methods. Experimental validation confirmed the feasibility of directly estimating respirable dust mass concentration, with relative errors within ±15%.

10:05 am

26-039

Modeling Diesel Particulate Matter (DPM) Transport and Dilution Behavior in Large-Opening Underground Mines Using a Coupled CFD Approach

X. Song and S. Liu; Penn State, State College, PA

Diesel particulate matter (DPM) presents considerable occupational health hazards in large-opening underground mines (LOUM). Previous studies have primarily focused on single-factor ventilation optimization, while this study innovatively integrates booster fan configurations and loading truck placements utilizing a coupled CFD turbulence–particle tracing model. Three distinct ventilation scenarios were simulated to evaluate their effects on DPM dispersion and dilution behaviors. Results indicate that: (1) dual booster fans substantially enhance airflow distribution, increasing air exchange efficiency from 30% to 48%; (2) the migration pathways of DPM closely align with airflow trajectories, and air turbulence is the predominant factor influencing DPM transport behavior within LOUM; (3) loading truck placement critically influences local DPM accumulation; (4) airflow movement diminishes with distance at downstream of booster fans, causing stagnation at distant working faces. The coupled CFD approach can capture airflow–particle interactions, offering valuable insights for optimizing mine ventilation strategies and effectively mitigating miners' exposure to DPM.

10:25 am

Digitizing Historical Dust Explosion Data for Modern Safety Analysis and Facility Design

J. Torres Quintana, C. Johnson and A. Douglas; Missouri University of Science and Technology, Rolla, MO

Understanding underground explosions is essential for safety in mining and construction. However, much of the historical data from NIOSH's Lake Lynn facility remains underutilized. This investigation presents a systematic approach to recover, digitize, and classify this data, focusing on pressure and flame intensity trends. The resulting digital database enables comprehensive analysis across different test series, providing a framework for researchers to conduct meta-analysis in their area of interest and expertise. Example analyses highlight how these legacy records can inform future research and safer practices. Impulse, the integral of pressure over time, is discussed in detail as the overall energy loading, not just peak pressure, is critical for accurate safety assessments.

10:45 am

US Underground Coal Auxilary Optimization

B. Cerklefskie; Turnstone Industrial Solutions, Winchester, KY

The process of underground coal optimization starts with understanding. Our team has studied all aspects of the auxiliary ventilation, particularly US Coal longwall operations, and have developed a procedure to effectively collect, communicate, and deploy predictable ventilation systems. Key fundamentals of our program are underground auditing, modeling "as-found" conditions, and development of a practical cascade of actions to be taken. Included in these processes digitizing the ventilation plan, confirming fan details, and heading underground to develop a complete operational snapshot. Within each operation, there are several operating configurations, each needs to separately scrutinized and processed. Permissible fans are outside of our scope, but we thoroughly understand the equipment and how it interacts with our tubing. We have found development of procedures, clear to understand checkpoints, and the data to support these actions, have resulted in meaningful outcomes. The purpose of the presentation to cover inputs and outputs of ours processes. Perspective on usage trends, as well as key similarities and differences will be provided.

Wednesday, February 25 Morning

COAL & ENERGY: MINE EMERGENCY PREPAREDNESS

151G

Chairs: ***E. Zeglen****, Zeglen Consulting, Clarksville, PA*
J. Brady*, West Virginia University*

9:00 am

Introductions

9:05 am

Automated Post-Disaster Monitoring in Underground Mines Using Image and Point Cloud Analysis

A. Tejada Peralta[1], K. Joao[1], H. Khaniani[2], V. Androulakis[2], M. Hassanalian[2], S. Shao[3] and P. Roghanchi[1]; [1]University of Kentucky, Lexington, KY; [2]New Mexico Institute of Mining and Technology, Socorro, NM and [3]Colorado School of Mines, Golden, CO

Post-disaster monitoring in underground mines is essential to ensure the safety of first responders and rescue teams. This project presents an automated system that combines 360-degree imagery and 3D LiDAR point cloud data collected by Unmanned Ground Vehicles (UGVs) and Unmanned Aerial Vehicles (UAVs) to remotely assess underground environments post-accident. The system used Iterative Closest Point (ICP) algorithms to align pre- and post-event LiDAR scans and detect structural changes in the mine. In parallel, image processing and machine learning techniques were used to identify environmental changes and detect key objects of interest. A pretrained deep learning model was fine-tuned using data from underground environments to improve object detection accuracy. The fine-tuned model was then compared to standard pretrained models, and it demonstrated superior performance in detecting relevant objects under challenging underground conditions. By integrating both 2D image analysis and 3D spatial data, the system enhances situational awareness and enables faster, data-driven decision-making in emergency scenarios.

9:25 am

Toward Effective Interfaces for Underground Rescue Robots: Incorporating Human Factors and End Users' Needs

R. bakzadeh[1], H. Khaniani[2], V. Androulakis[2], M. Hassanalian[2], S. Shao[3] and P. Roghanchi[1]; [1]University of Kentucky, Lexington, KY; [2]New Mexico Tech, Socorro, NM and [3]Colorado School of Mines, Golden, CO

This study designs a user-centered interface that integrates search and rescue personnel and applies human factors principles to enhance usability. Robots support emergency response by entering hazardous areas, especially in underground mine rescue operations. Due to unpredictable conditions, human oversight is essential. However, deploying robots in such environments is challenging, particularly when interfaces do not reflect end-users' expectations or human factors. The goal of this study is to improve communication, situational awareness, and decision-making speed. A user-centered interface enables more effective robot deployment, faster data transfer, and helps keep rescue personnel safe, ultimately saving lives in underground emergency scenarios.

9:45 am

Ray-Tracing-Based Simulation and Optimization of Redundant Node Placement for Electromagnetic Wave Propagation in Obstructed Underground Mine Environments

E. Antwi, S. Frimpong and M. Raza; Missouri University of Science and Technology, Rolla, MO

Reliable wireless communication is critical to underground mine safety, especially during emergencies where coordination, localization, and self-escape are essential. The complexity and dynamism of geometries and obstructions emergencies like ground fall and explosions can cause communication network breakdown, hindering rescue and self-escape attempts. While redundant node placement is often used to improve network resilience, it is unsustainable due to the inability to adapt to rapidly changing environments. This work presents a novel approach that integrates stochastic obstructions modeling and node placement optimization into ray tracing that captures multipath effect and material specific attenuation for realistic signal prediction in complex mine layouts. Utilizing the Missouri S&T Experimental Mine as a case study, wave propagation simulations are performed with Wireless InSite to assess signal attenuation and identify optimal areas for redundant node placement in obstructed scenarios. The outcome of this work provides emergency-ready network planning support and advances mine safety goals through stronger wireless communication resilience.

10:05 am

Predictive Human-Machine Interaction for Underground Mine Rescue Using VR and LSTM-Based Decision Modeling

M. Van Wyk[1], R. bakzadeh[2], P. Roghanchi[2], M. Hassanalian[1] and H. Khaniani[1]; [1]New Mexico Tech, Socorro, NM and [2]University of Kentucky, Lexington, KY

Underground mine emergencies demand rapid decisions under extreme stress, where fatigue, limited visibility, and toxic gases can compromise human judgment. Traditional safety training lacks predictive capabilities to support decision-making during dynamic hazards such as fire, CO accumulation, and oxygen depletion. This study integrates virtual reality (VR) simulations, sensor-rich environments, and Long Short-Term Memory (LSTM) neural networks to forecast miner decisions during rescue operations. A VR replica of a room-and-pillar coal mine with 200+ sensors monitored gas concentrations, air velocity, temperature, and positional data from 30 participants engaged in simulated rescues of trapped miners. LSTM models achieved over 68% accuracy in predicting decision strategies, which clustered into direct rescue, exploratory, and avoidance archetypes. Results show that predictive analytics and VR-enhanced human-machine interaction can improve situational awareness and cognitive performance, advancing real-time decision support for safer, digitalized mine operations.

10:25 am

Enhancing Mine Evacuation Systems with Machine Learning and Digital Twin Based Graph Neural Networks

N. Crosato[1], N. Mojtabai[1], M. Hassanalian[1], P. Roghanchi[2] and H. Khaniani[1]; [1]New Mexico Tech, Socorro, NM and [2]University of Kentucky, Lexington, KY

This study presents the development of an intelligent mine evacuation system under a NIOSH sponsored initiative, integrating artificial intelligence, digital twins, and immersive simulation for enhanced underground safety. The system employs Graph Neural Networks (GNNs) to evaluate the safety of each node within a mine layout using real time environmental data, including gas concentrations, temperature, and airflow, which are fed from a physical simulation rig replicating underground emergency conditions. By dynamically predicting optimal escape routes, the model adapts to evolving hazards and supports timely decision making. Predicted evacuation paths are embedded into a Unity based 3D digital twin of the mine, providing an interactive, fully VR compatible environment for both training and live simulation. This immersive approach bridges AI driven predictions with experiential learning, improving situational awareness, decision making, and preparedness for hazardous scenarios. The research establishes a framework for AI enabled evacuation planning that leverages simulation rig data to enhance both real time response and proactive safety training in underground mining operations.

Wednesday, February 25 Morning

COAL & ENERGY: MINING MACHINES & EQUIPMENT

Sponsored by BARR

151 A-C

Chairs: ***J. Haughey****, Komatsu, Warrendale, PA*
C. Nyikos*, Barr Engineering, Portland, OR*

9:00 am

Introductions

9:05 am

26-061

Tracking Shuttle Car Loading Weight and Distribution

J. Strydom, S. Schafrik, Z. Agioutantis and D. Beck; University of Kentucky, Lexington, KY

Automation of the underground loading and hauling process will aid to reduce work-related musculoskeletal injuries and effectively eliminate the risk of exposure to airborne pollutants. Appropriate monitoring of the payload weight and distribution of the load in a shuttle car bed is required for automating the chain conveyor jogging to ensure an evenly distributed load. The methodology applied can readily be adopted to other haulage equipment. This presentation discusses the computational model that was developed to evaluate the thermo-mechanical response of strain transducers, housings and substrate infrastructure. In conjunction with FEM analysis, the fabrication and experimental verification process of strain transducer material, the extent of temperature induced strain and the installation trials developed are delineated and discussed.

9:25 am

26-001

A Discrete Event Simulation Approach to Haul Truck Maintenance in Coal Mining Operations

S. Sahiner and O. Golbasi; Middle East Technical University, Ankara, Turkey

Effective maintenance planning is vital for coal mining operations, where haul truck fleets directly determine production continuity. This study presents a discrete event simulation (DES) model for evaluating maintenance strategies under multiple failure modes and their interdependencies. The model integrates corrective, periodic preventive, and opportunistic maintenance, dynamically updating equipment lifetimes through probabilistic time-between-failure and time-to-repair distributions. Applied to a five-truck coal haulage fleet over a one-year horizon, results show that periodic preventive maintenance delivers the highest availability (76%) under unconstrained conditions, slightly outperforming corrective-only maintenance (75%). Opportunistic and integrated approaches performed worse (68% and 69%), reflecting redundancy from overlapping interventions. These findings suggest that structured preventive programs provide the most reliable outcomes when costs and resources are not limiting. The DES framework serves as a baseline for future models incorporating cost, spare parts logistics, and workforce availability, supporting robust maintenance planning in coal mining operations.

9:45 am

Adapting an Autonomous Shuttle Car Navigation Routine to ROS

A. Lupachino; Univeristy of Kentucky, Lebanon, KY

In previous work, the authors have shown that autonomous shuttle cars can navigate effectively underground using input information from LIDAR. The navigation algorithm was purpose built, using novel data handling schemes and logic. However, when transitioning from an experimental sensor loadout to a sensor loadout that could be used on a production or rebuilt shuttle car, the authors have decided to use RADAR instead of LIDAR. In addition, the standard control software for autonomous vehicles, ROS, has many benefits that would need to be developed to use the developed navigation algorithm. ROS allows for users to make modules that modify the program's default behavior and processing. This work will present the challenges and progress that is being made to adapt a working underground navigation algorithm to different sensors and the ROS platform.

10:05 am

The Effect of Pass Match and Asset Utilization on Efficiency and Cost Per Ton

J. Marek; Caterpillar, St. Charles, IL

It is often observed in production studies that the operating technique and system match has an equal or greater effect on production and efficiency as the difference between one machine and another. Only when both the machine and its interaction with the mining system are optimized can a differentiated level of cost per ton and fuel efficiency can be achieved. This discussion will examine a case study on the effect of pass match between a truck and loading tool along with the effect of asset utilization on the efficiency and cost per ton of the wheel loader.

10:25 am

26-051

Real-Time Wear Monitoring for Predictive Maintenance in Mineral Processing

C. Vaughan; 2Censor, Erakala, QLD, Australia

Unplanned shutdowns from abrasive wear part failure in crushers, chutes, and slurry pipe assets can cost millions in lost production and reactive maintenance. 2Censor's patented sensor technology enables real-time abrasive wear monitoring of mineral processing equipment, turning passive assets into smart, data-driven components. Wireless sensors embedded in liners and pipework transmit wear data live to operators, allowing for predictive maintenance, safer scheduling, and optimized asset life. This paper will present global case studies showing reductions in downtime, increased throughput, and improved maintenance accuracy. The system is retrofit-ready, OEM-agnostic, and proven across more than 12 countries in abrasive wear liners and slurry pipe applications.

10:45 am

Temporal Machine Learning for Predicting Accidents and Violations in the Mining Industry

N. Kelley; University of Kentucky, Providence, KY

This project looks to evaluate a temporal machine learning model's ability to predict future accidents and violations for specific mines based on historical MSHA datasets. The optimal algorithms were determined based on the F1-score when predicting the fourth most cited accident classification and the third most cited violation, categorized by part section, in the underground coal dataset. The algorithms were then used to predict the top ten most cited accidents and violations in the surface and underground coal, metal, and nonmetal datasets. When paired with the highest-performing recall and precision algorithms, a risk level can be developed for the mine operator. This feature, along with the ability to display specific information in the datasets, was combined into a user-friendly interface.

Wednesday, February 25
Morning

ENVIRONMENTAL: SUSTAINABLE MINE WATER MANAGEMENT AND TREATMENT FOR EFFECTIVE RECLAMATION AND CLOSURE

Sponsored by ARCADIS

255A

Chairs: ***M. Hay****, Arcadis U.S., Inc., Broomfield, CO*
J. Gillow*, Arcadis, Denver, CO*

9:00 am

Introductions

9:05 am

30+ Years of Operation of Passive Water Treatment System Highlights Effectiveness and Sustainability Benefits

I. Montero[1], J. Harris[1], L. Schultz[2], D. Griffis[1] and L. Pokorny[1]; [1]Remediation Management Services Company, Houston, TX and [2]Trihydro, Anaconda, MT

Warm Springs Ponds (WSP) is a large passive water treatment system operating in the Silver Bow Creek watershed for 30+ years. WSP's influent water quality is subject to natural stream variability and upstream remedial actions addressing the outcomes from historic mining operations. WSP's lime dosing system, managed flow channels and wet and dry closures facilitate settling, precipitation and/or sorption of metals and their sequestration under self-sustaining sediment caps. WSP is a significant regional biodiversity and sustainability asset that provides substantial ecosystem services, ecological benefits to hundreds of species of waterfowl and mammals and sustainable management of flood waters.

9:25 am

Turning Mine Waste into Treasure: The Story of Zinc Recovery in Colorado

L. Figueroa; Colorado School of Mines, Golden, CO

Recovering critical minerals from mine waste offers a promising way to boost our domestic supply—turning environmental problems into valuable resources. At the Wellington Oro mine near Breckenridge, Colorado, a water treatment plant successfully extracted zinc from contaminated water, producing a zinc sulfide product accepted by the Nyrstar Smelter in Tennessee. However, that partnership recently came to a halt. This presentation explores the rise and fall of that innovative collaboration—how it started, what made it work, and why it ultimately ended. By examining the challenges that prevented the continued use of this recovered zinc, we gain insight into the complex roadblocks that still stand in the way of integrating mine waste materials into the broader mineral supply chain.

9:45 am

A Novel Bioremediation Treatment System using Bioaugmentation to Target Manganese Removal

L. Santisteban[1], S. Isleyen[1] and B. Nielsen[2]; [1]Freeport-McMoRan, Oro Valley, AZ and [2]Freeport-McMoRan, Phoenix, AZ

This paper details a water treatment system constructed to treat drainage from an electrolytic manganese residue repository in the eastern United States as part of recent site improvements. The goal is to improve effluent water quality and not degrade the receiving stream. The first stage neutralizes acidity and increases pH, followed by a second stage that aerates water. The treatment wetland then targets Mn (oxy)hydroxide and Mn carbonate precipitation. The final (polishing) stage promotes additional Mn precipitation. Bioaugmentation was used to re-introduce Mn-oxidizing bacteria. We discuss results from the first year of operation and lessons learned.

10:05 am

Post-Closure Stability of Selenium in Saturated Coal Mine Rock Fills

L. Kirk[1], S. Das[2], M. Hendry[2], P. Blanchard[4], S. Shaw[3] and B. Peyton[5]; [1]Enviromin, a division of RESPEC, Bozeman, MT; [2]University of Saskatchewan, Saskatoon, SK, Canada; [3]SRK Consulting (Canada), Vancouver, BC, Canada; [4]Canadian Light Source, Saskatoon, SK, Canada and [5]Montana State University, Bozeman, MT

Saturated rock fill (SRF) technology is a robust and sustainable approach to reduce selenate in coal mine water to sorbed selenite and/or insoluble elemental selenium using native bacteria. Mineralogical analyses of selenium in biomineralized samples recovered from the full-scale EVR Elkview Coal Mine SRF trial identified selenite strongly sorbed to ferrihydrite and reduced Se_nS_{n-8} minerals. Selenium was not remobilized from batch tests after nutrient amendment was stopped or from columns held static at neutral pH, low oxygen, and reduced conditions for 5 years with intermittent flow to mimic post-closure SRF conditions. Selenium adsorption-desorption experiments indicated selenite was strongly sorbed to ferrihydrite in coal mine rock with minimal desorption. Results suggest that selenium in SRF treatment reactors will likely be very stable and unlikely to negatively affect surface water or groundwater post closure.

10:25 am

Pilot Demonstration of the Alkaline Flush Technology for Treatment of an Acidic, Metals-Impacted Alluvial Aquifer System in New Mexico

M. Raghav[1], J. Szaro[1], P. Pinson[2] and W. King[2]; [1]Freeport-McMoRan Inc, Phoenix, AZ and [2]Freeport-McMoRan Chino Mines Company, Bayard, NM

Alkaline Flush (ALF) technology entails the introduction of alkaline water into an acidic alluvial groundwater system to increase aqueous pH, neutralize sediment acidity, and add residual sediment alkalinity. The increased pH promotes sequestration of metals into relatively stable minerals, lowering aqueous and sediment acidity. The residual sediment alkalinity may provide buffering against potential future impacts. We present findings from a pilot study evaluating ALF for treatment of an acidic alluvial aquifer system in New Mexico. The feasibility and effectiveness of ALF was demonstrated using a multi-pronged approach, evaluating aqueous chemistry, sediment titration, and mineralogical data, along with geochemical modeling results.

10:45 am

Bioremediation of Acid Mine Drainage Using Extremophile Microalgae: A Sustainable Approach for Heavy Metal Removal and Resource Recovery

A. Bhattacharya, S. Jayaraman Sridharan, P. Tukkaraja and V. Gadhamshetty; South Dakota School of Mines and Technology, Rapid City, SD

Acid mine drainage (AMD), characterized by low pH and high concentrations of toxic heavy metals, poses a significant threat to aquatic ecosystems and public health. Conventional treatment methods are often costly and generate secondary waste. This study explores the potential of the extremophile microalga Galdieria sulphuraria for AMD bioremediation under synthetic conditions mimicking coal mine effluents. Cultured in Cyanidium medium across varying dilutions of synthetic AMD, G. sulphuraria demonstrated optimal growth, chlorophyll synthesis, and lipid productivity at a 15× dilution (D15), indicating resilience to heavy metal stress. The microalga achieved notable removal efficiencies for key contaminants including Fe (19%), Mn (49%), Cu (38%), Co (50%), Zn (38%), Ni (23%), and Al (73%), aligning with or surpassing USEPA discharge standards. Additionally, sulfate and nitrate removal efficiencies reached 37% and 95%, respectively. The study demonstrates effective AMD detoxification with potential applications in rare earth element recovery. These findings support the integration of microalgal systems into passive bioreactors for sustainable mine water treatment.

11:05 am

Water Treatment Cost Savings Through Landform Design and Water Management: A Conceptual Case Study

C. Pretorius[1], Y. Allé-Ando[2] and K. Minchow[3]; [1]Ensero Solutions, Toronto, ON, Canada; [2]Okane Consultants, Calgary, AB, Canada and [3]Ensero Solutions, Dillon, CO

This paper examines how alternative mine rock and water management can reduce lifecycle water treatment costs. Conventional Mine Rock Stockpile (MRS) construction typically increases metal leaching and acid rock drainage (ML-ARD), creating multigenerational water quality risks that require extensive collection, conveyance, storage, and treatment infrastructure—often in perpetuity. Traditional lime treatment and membrane systems produces waste streams requiring long-term disposal plans. A source control philosophy for MRS landform design can significantly reduce ML-ARD risk and associated costs. Integrating passive or semi-passive water treatment solutions into mine landscapes further enhances this approach's value. This evaluation compares capital and operating costs between conventional MRS placement with traditional effluent treatment versus source-controlled MRS construction paired with passive water treatment design.

Wednesday, February 25
Morning

ENVIRONMENTAL: THE UPSIDE OF FAILURE

255D

Chairs: ***R. Furey****, Stantec, Broomfield, CO*
H. Lammers*, Colorado School of Mines, WSP, Golden, CO*

9:00 am

Introductions

9:05 am

Failing Elegantly

A. Watson; Stantec, Lakewood, CO

All ships are safe in port, but that's not what ships are for! In our business, we are challenged to take on risk, to invest our shareholders' capital in ventures that yield a return. Great equestrians fall off their horses, and race-car drivers blow up engines. They keep on learning to perfect their craft. We also exist in a business where pushing the limits is part of our competitive edge, but we wish to avoid blowing up the business, shutting down the operation or hurting anybody. The "school of hard knocks" is part of our folklore, and modest setbacks point out weaknesses that can be addressed. That way the business continues and we have an opportunity to imrpove through learning and adaptation. This is of great importance to the industry as we enter into the very long-term promises being made regarding features like tailings dams, waste piles and pit slopes. There is a good chance that over the next 1000 years a few of our assumptions might be incorrect, and our estimates wrong. Our job then is to apply adaptive management and make sure that small failures are detected early and adressed promptly.

9:25 am

To Channel or Not to Channel: Drainage Density and Flow Concentration

T. Braun; SRK Consulting (U.S.), Inc., Denver, CO

Constructed landform designs for post-mining landscapes seek to establish rates of erosion comparable to those of natural landforms in similar watersheds and climate. Design of surface water conveyance systems for a constructed landform considers drainage density, i.e., the number of drainage "lines" per unit area. Drainage density may be minimized in an effort to minimize flow concentration or simulated based on the number of drainage lines in natural analog. This paper examines observed failures with design elements under both approaches. These failure narratives provide insight to design methodology, technical trade-offs and implementation risks. The erosional failure of a minimum drainage density design occurred on reclaimed outslope of a closed copper tailings facility in the arid southwest U.S. The failure consequence was unplanned and extended maintenance of the erosion-resistant soil-rock cover system near the upper reach of the embankment. The erosional failure of a moderate drainage density design involved overland flow into a concrete lined channel. In this case, surface water preferentially bypassed the channel.

9:45 am

5 Ways to Blow Up Your Piping System

M. White; WestLand Engineering and Environmental Services, Tucson, AZ, 85712, AZ

Archeologist have discovered rudimentary piping systems dating all the way back to ancient Egypt. And yet, we still manage to break them over and over again. There are so many complex factors in piping system design and operation that can be easily overlooked and yet cause devastating results. From warped equipment caused by temperature shifts in an under-restrained pipe, to pipe wall collapse due to surge and vacuum conditions—unfortunately—we've seen it all. We'll be sharing anecdotes from various types of failed systems covering topics such as air locking, hydraulic surge, and thermal contraction. Our mini case studies will include what went wrong, why, and how to pick up the pieces afterwards so that you, too, can blow up your piping systems in interesting new ways.

10:05 am

Keys to Success for Operations-Wide EQuIS Implementation at Freeport-McMoRan Americas

R. Bothun[1] and J. Bryant[2]; [1]ddms, inc., Saint Paul, MN and [2]Freeport-McMoRan, Empire, CO

Freeport-McMoRan partnered with ddms, inc. to centralize water quality data across 16 sites using EQuIS, enhancing regulatory compliance, operational efficiency and corporate visibility. Success was driven by strong stakeholder engagement—from site users to senior leadership—and a strategy focused on standardization and minimal customization to support long-term maintainability. ddms managed multiple implementation threads in parallel, accelerating progress while maintaining consistency. As with any complex effort, challenges arose, and key lessons learned will be shared. With a strong foundation in place, Freeport is now well-positioned to expand to additional programs and leverage analytics for deeper insights.

10:25 am

Streamlining Success: Strategies to Minimize Permitting Delays for New Mining Projects

S. Braun[1] and W. Slaugh[2]; [1]Barr Engineering Co., Minneapolis, MN and [2]Pacific Soda LLC, Green River, WY

Navigating a new mine development through the regulatory approval process can feel overwhelming and frustrating, but these feelings can be mitigated with a solid plan at project initiation. This discussion will focus on key strategies for minimizing regulatory approval delays for your mine site, including setting yourself up for a successful project as well as setting your project up for successful agency review. We will discuss how these strategies were applied or could have been more strongly applied to a new, greenfield mine in southwest Wyoming.

10:45 am

26-029

Environmental Liability and Risk Related to Mine Closure – Where did my NPV Go?

J. McKinley; SLR Consulting, Calgary, AB, Canada

With a growing number of mines reaching closure and realizing closure costs, regulators, lenders, and banks are observing projects that fail economically by miscalculating these costs. Net present value (NPV) analysis has traditionally been misapplied to projects that have activities occurring into perpetuity. Additionally, closure plans often do not consider subsidies for portions of the closure landscape that increase natural capital and/or generate revenue. Banks will lend more to a company if the company's liability decreases. Closure costs and liability can decrease during improved NPV analysis, but usually only if there is a shift in closure strategy, which has a much greater chance of being successful if it is applied early. Often, decisions made before Day 1 of mining can significantly change the liability calculation. Applied science can be used for progressive bond release prior to closure. Bonds are reevaluated every five years so every company will go through this financing challenge. Bond holders don't have to wait decades to see if closure works; the operator can complete pilot studies during operations to derisk closure and progressively return parts of the bond.

Wednesday, February 25
Morning

HEALTH & SAFETY: MAKING SAFETY TECHNOLOGY WORK FOR YOU: TOOLS, TRENDS, AND LESSONS FROM THE FIELD

Sponsored by RioTinto

250A

Chairs: ***P. Rogers****, University of Utah, Salt Lake City, UT*
K. Awuah-Offei*, Missouri University of Science & Technology, Rolla, MO*

9:00 am

Introductions

9:05 am

26-020

Deep-Learning Assisted Prediction of Lithium-Ion Battery Thermal Runaway in Subsurface Mining Conditions Based on Experimental Data

K. Said[2], U. Mishra[1], S. Bhattacharyya[2] and A. Kumar[2]; [1]Pennsylvania State University, State College, PA and [2]The Pennsylvania State University, State College, PA

Using battery-powered equipment in underground mining can improve safety, advance automation, and reduce greenhouse gas emissions. In this context, rechargeable lithium-ion batteries (LIBs) have a competitive edge due to their high Columbic efficiency, superior energy density, and extended cycling stability. However, several conditions must be met for their safe operation. Their failure can cause thermal runaway (TR), which poses a significant safety risk in underground mines. Despite studies having investigated this phenomenon using physics-based models, limited research has used deep learning to predict its implications. This study aims to bridge this gap by characterizing LIB TR under dynamic airflow using experiments and predicting temperature and smoke using two of the most common recurrent neural networks, including long short-term memory (LSTM) and gated recurrent neural networks (GRU).

9:25 am

Advancing Mining Safety Analytics: Domain-Adaptive Language Models for Automated Safety Information Extraction

A. Danish; Michigan Technological University, Houghton, MI

Traditional general-purpose language models face significant limitations in understanding domain-specific safety language and terminology, limiting their effectiveness in safety-critical applications. This research addresses this gap through domain adaptive language modeling and automated safety information extraction for mining safety analytics by employing Domain-Adaptive Pretraining (DAPT) of Bidirectional Encoder Representations from Transformers (BERT) on a multi-source safety corpus spanning across industrial sectors for domain adaptation and using the resulting model (SafetyBERT) for extractive question answering (QA) system to automatically extract critical safety information, such as incident causes, work activities, and injury types, from unstructured narratives. The resulting model demonstrates substantial improvements, outperforming general-domain and larger models, including Llama 3.1-8B. This integrated approach enables proactive hazard management and targeted safety interventions, providing a practical solution for leveraging unstructured safety narratives in organizational safety management systems.

9:45 am

CFD Modeling of the Evolution of the Products of Lithium-Ion Battery Thermal Runaway: A LES–RANS Comparative Study

K. Said, S. Bhattacharyya and A. Kumar; Pennsylvania State University, State College, PA

Lithium-ion batteries (LIBs) in underground mines present a hazard due to the potential of rapid failure through thermal runaway (TR). This study presents a comparative analysis of Large Eddy Simulation (LES) and Reynolds-Averaged Navier-Stokes (RANS) models in understanding the spatio-temporal evolution of heat, gas species, and smoke particulates during LIB TR. LES resolves large-scale turbulent eddies and transient features that are critical to capturing plume dynamics and stratification in confined domains, whereas RANS relies on time-averaged turbulence closure models, offering computational efficiency at the expense of transient-state high fidelity data. Results from these models will be useful in creating reduced-order models for control and estimation algorithms.

10:05 am

Comparative Suppression Performance of Water, Nitrogen, and ABC Dry Powder on Lithium-Ion Battery Fires

A. Iqbal, A. Kakoria and G. Xu; Missouri University of Science and Technology, Rolla, MO

Lithium-ion battery (LIB) fires burn hot and can reignite after being put out. Most past studies focus on safer LFP cells or large formats. But Electric Vehicles (EVs) often use small NMC and NCA cells, which are more reactive. There isn't much data on how to handle fires from these chemistries. This study explores how three common extinguishers, water, nitrogen, and ABC dry powder interact with 18650 NMC and NCA cells at 75% State of Charge (SOC). We measured suppression time, agent amount, and cooling rate. Water cooled fastest, ABC powder showed potential to prevent reignition, and nitrogen reduced flames but didn't cool well. Prior studies suggest suppression depends on both agent mechanism and battery chemistry. For example, ABC powder may chemically insulate reactive surfaces, while water removes heat but can allow reheating. Whether our results follow these trends remains to be seen. This work helps explain why some agents work better than others based on battery type. It also provides data that can be used to improve fire behavior models, predict suppression outcomes, and design safer battery systems.

10:25 am

Evaluating a Passive-Back Support Exoskeleton in Simulated Underground Coal Mining Conditions

E. Okyere[1], N. Ripepi[1], B. Nojabaei[1] and A. Asbeck[2]; [1]Virginia Tech, Blacksburg, VA and [2]Co-Author, BLACKSBURG, VA

This study evaluates a passive back-support exoskeleton in a mock mine environment (Mock Mine, Virginia Tech) designed to simulate underground coal mining conditions, including a low ceiling height of four to five feet. Repetitive lifting tasks were performed with and without the exoskeleton. Physiological responses were recorded using a Garmin heart rate monitor and surface electromyography (sEMG) sensors. Results showed reductions in mean heart rate and heart rate variability, when the exoskeleton was used, indicating reduced physical strain. These findings support the exoskeleton's potential to mitigate musculoskeletal disorder (MSD) risks among underground miners, with future work focused on extended field validation in actual mines.

10:45 am

Effects of Two Passive Arm-Support Exoskeletons on Physical Demands and User Perceptions in Simulated Manual Mining Tasks

F. Akinwande, S. Kim and M. Nussbaum; Virginia Tech, Blacksburg, VA

Arm-support exoskeletons (ASEs) can decrease physical demands during occupational tasks, but their effectiveness in manual mining tasks remains unknown. Eighteen participants performed simulated cable installation, core box lifting, wiremesh installation, and overhead drilling tasks in a lab setting, using two ASEs and with no-ASE. One ASE significantly reduced total shoulder muscle (TSM) activity during cable installation (~23%), core box lifting (~22%), and wiremesh installation (~24%); the other ASE only reduced TSM during wiremesh installation (~17%). Both ASEs significantly reduced perceived exertion, though participants reported discomfort. ASEs appear promising for injury prevention, yet future work should test them among miners.

11:05 am

Framework for Evaluating and Certifying Event Cameras for Enhanced Safety and Automation in Underground Mining Operations

A. Conteh; Colorado School of Mines, Golden, Colorado, CO

Using and operating optical devices in underground mining is challenging due to dust, water vapor, mist, and mud obstructing visibility. Devices like RGB, thermal, hyperspectral, and stereo cameras often struggle in such conditions. Event cameras, which detect changes in brightness rather than capturing full frames, offer a promising alternative for automation tasks such as bolter guidance. With high dynamic range and low motion blur, they are well-suited to harsh mining environments. This paper reviews conventional optical devices and their limitations, explores the use of event cameras for motion detection, equipment tracking, and autonomous perception, and proposes a certification pathway aligned with MSHA and ATEX standards. It highlights integration challenges and outlines key priorities for advancing computer vision in underground mining.

11:25 am

Advances in Automation and Robotics: State of the Emerging Future Mining Industry

M. Obosu and S. Frimpong; Missouri University of Science and Technology, Rolla, MO

The mining industry is evolving rapidly through the adoption of intelligent technologies aimed at eliminating fatalities and improving operational efficiency. This paper reviews the integration of automation, robotics, AI, machine learning, IoT, drones, and remote monitoring in enhancing safety, precision, and sustainability. Autonomous systems enable continuous operation in hazardous environments, reducing human exposure and improving risk management. These technologies optimize drilling, excavation, and material handling while expediting emergency response. The paper highlights recent advancements, evaluates challenges, and explores future prospects. Its novelty lies in presenting a forward-looking synthesis of how intelligent systems will shape the emerging mining industry of the future.

Wednesday, February 25 Morning

INCLUSION & DIVERSITY: INTERNATIONAL PERSPECTIVES AND COLLABORATION IN MINING - PANEL SESSION

250B

Chairs: ***Z. Scopa****, Cargill Inc, Ithaca, NY*
P. Christensen*, RESPEC, Littleton, CO*

9:00 am

Introductions

9:05 am

Inclusion & Diversity: International Perspectives and Collaboration in Mining

Z. Scopa[1], P. Christensen[2] and S. Cox[3]; [1]Cargill Deicing Solutions, Lansing, NY, [2]RESPEC, Denver, CO and [3]WSP, Tucson, AZ

Mining is a global industry that requires international collaboration with diverse representation. Within SME international representation is growing rapidly. Our panelists from around the globe will explore cultural differences and discuss the critically of multinational involvement in mining and how inclusion & diversity can drive high level collaboration.

Wednesday, February 25 Morning

INDUSTRIAL MINERALS & AGGREGATES: PROCESSING, RECYCLING AND SUSTAINABILITY IN INDUSTRIAL MINERALS AND AGGREGATES

250C

Chair: ***S. TRIPATHY****, National Resources Research Institute, University of Minnesota Duluth, Grand Rapids, MN*

9:00 am

Introductions

9:05 am

Integrated Water Recycling and Fines Recovery for Sustainable Aggregates Production: A Case Study at Vulcan Materials Franklin Quarry

V. Kona[1] and C. Jenson[2]; [1]Vulcan Materials Co, Brentwood, NH and [2]McLanahan, Gallatin, MT

Vulcan Materials Company is implementing an integrated water recycling and fines recovery system at its Franklin Quarry, Tennessee. This initiative significantly reduces municipal water reliance and enhances water security during droughts. The system, featuring a 40 ft clarifier and 3-meter 4-roll belt filter press, treats up to 35 tph of fines, achieving over 90% water recovery from the wash plant effluent for immediate reuse. The beneficial reuse of recovered fines, blended into base products or sold as fill material, is a key aspect. Excess material will be managed via controlled underground storage or surface stockpiling for future blending, maximizing resource efficiency. The project strategically optimizes site infrastructure by repurposing Pond B1 and utilizing the area for the new plant. This includes detailed civil design for deep foundations using overburden and shotrock, and comprehensive erosion control. Automation and PLC controls ensure efficient operation. This sustainable solution exemplifies advanced water and material management practices for the aggregates industry, delivering significant environmental and operational benefits.

9:25 am

Unearthing the Hidden Impacts of Global Lithium Recycling

M. Heydari; University of Cambridge, Cambridge, Cambridgeshire, United Kingdom

As the global economy pivots toward decarbonization, demand for critical minerals (CMs) essential to low-carbon energy technologies continues to climb. Lithium (Li), a linchpin CM for battery storage, has experienced pronounced supply–demand imbalances over the past decade, exposing supply-chain vulnerabilities and heightening concerns over resource stability. While Li-recycling has emerged as a promising avenue to offset primary-supply shortfalls, the hidden environmental, social, and economic impacts of recycling remain largely understudied. This work presents the first comprehensive survey of current global lithium-recycling capacities and, through a lifecycle lens, quantifies their downstream impacts, including energy and water footprints, community health risks, and regional employment dynamics, identifying key hotspots and opportunity areas. By pinpointing where environmental burdens, social equity concerns, and cost-benefit trade-offs converge, it proposes targeted mitigation strategies to ensure that scaling Li-recycling supports a genuinely sustainable, responsible, and equitable energy-transition supply chain.

9:45 am

A Pragmatic Framework and its Application for Assessing the Sustainability of Critical Minerals Extraction from Industrial By-Products: Evidence from the United States

P. Duah and K. Awuah-Offei; Missouri University of Science and Technology, Rolla, MO

Research evidence suggests that coal ash contains economically viable concentrations of critical minerals, which are indispensable to a resilient global energy transition. In the United States, about 2 billion tons of ash have been landfilled or impounded. Harvesting and processing this material can reduce ecotoxicity and carcinogenic impacts associated with its disposal and leachate generation. Leveraging comprehensive national data, we present a sustainability-centered framework that assesses their environmental trade-offs, recovery potential, and circularity. Our findings suggest that coal ash valorization in the United States advances critical minerals supply chain security, significantly mitigates environmental burden and risks to human health.

10:05 am

Integrating SK-1300-Compliant Reserve Estimation and Low-Carbon Strategies in Project Development at Cementos Pacasmayo

M. Carrasco; Mining And Metallurgical Society of America, Tampa, FL

Cementos Pacasmayo, the second-largest cement producer in Peru, integrates project management, sustainability, and reserve estimation in accordance with SK-1300 to advance low-carbon cement production. Its key initiatives include reducing clinker content through the use of supplementary cementitious materials (SCMs) such as pozzolan, slag, and ground limestone. In parallel, the company applies advanced practices in geological modeling, block simulations, and resource classification to ensure accurate estimation of limestone reserves. This approach strengthens technical planning, enhances regulatory transparency, and serves as a replicable model for sustainable non-metallic mining operations.

10:25 am

Selective Metals Recovery in Aqueous Waste Streams

L. Billin; Linkan Engineering, Elko, NV

Aqueous waste streams contain concentrations of valuable, recoverable metals that may report as primary metals through inefficiencies in processing or as nontargeted secondary trace metals, including Rare Earths. Producers of diverse kinds can benefit from metals recovery from these waste streams, either through higher process metals concentration or secondary resale. Herein, Linkan, a leading expert in industrial wastewater treatment, presents our experience in producing concentrated value add streams from waste. We introduce specific metals for consideration and associated methods for recovery. We end by discussing integrational challenges with traditional systems.

10:45 am

Dense Phase Conveying for Aggregates & Minerals

D. Renfert and C. Egger; Cyclonaire, Manhattan, KS

For many aggregates and industrial minerals, pneumatic conveying is a practical and productive means to transfer materials to and from various unit operations common to typical processing plants. This paper will discuss how dense phase systems significantly reduce or eliminate damage to components or conveyed materials as compared to dilute phase systems by using lower conveying velocities to move materials in "pistons" or slugs rather than suspended in the gas stream. It will detail advantages of pneumatic conveying bulk solids as opposed to mechanical conveying. The paper will also present how using a pressure conveyor "pressure pot" as a conveying line charger eliminates many of the issues associated with other devices as line chargers.

11:05 am

Design Optimization for optimum Performance of a Hydrocyclone Based on Underflow Discharge Pattern: Spray, Transition and Roping

S. Pathak[1], D. Watson[2], S. Hunter[3], D. Switzer[4], S. Urankar[1] and T. R[1]; [1]Weir EnSci, Weir Minerals, Bangalore, India; [2]Weir Advanced Research Centre, Glasgow, United Kingdom; [3]Weir Minerals South Africa, Johannesburg, South Africa and [4]Weir Minerals North America, Madison, WI

This study investigates the influence of underflow discharge regimes—namely spray, transition, and roping—on classification efficiency and recirculating load of a hydrocyclone in a closed grinding circuit. A series of tests on a Weir Cavex® hydrocyclone revealed that a spigot-to-vortex finder diameter ratio of 0.67 yields optimal performance while varying operating parameter. Operational constraints associated with simultaneously achieving high classification efficiency and high circulating loads are critically examined. Further, A model has been developed on the rope condition and validated with the existing model. The approach can provide inference of optimization of spigot-to-vortex finder ratio and operational limitation, enhancing milling circuit performance.

11:25 am

Recovering Construction and Demolition Materials in Medellín: Opportunities and Barriers to Urban Mining

S. Gilson[1], M. Vélez-Fernández[2], I. Lopera Castaño[2] and N. Link[3]; [1]Colorado School of Mines, Englewood, CO; [2]Universidad Nacional de Colombia, Antioquia, Medellín, Colombia and [3]Colorado School of Mines, Golden, CO

Urban mining, the process of reclaiming materials from anthropogenic sources, is explored in Medellín, Colombia as a strategy for the recovery of uncontrolled construction and demolition waste (CDW). A literature review and life cycle assessment (LCA) evaluated the feasibility of recycling concrete aggregate (RCA), while site visits and interviews with recycling associations representatives, industrial producers, and circular economy stakeholders provided insight into small-scale recovery and reuse. LCA findings show that using RCAs in place of natural aggregates can reduce carbon emissions, resource extraction, and landfill use, though transport-related emissions limit their overall environmental sustainability. Field-based findings highlight that material separation and limited integration between recycling associations and industrial actors are key barriers to CDW recovery. Advancing urban mining in Medellín, therefore, requires improving source separation, stronger connections within the local supply chain, and policies that prioritize material reuse over disposal.

Wednesday, February 25
Morning

MINING & EXPLORATION: GEOSCIENCE: DATA TO DECISION: ESTABLISHING AND MANAGING ADEQUATE ORE BODY KNOWLEDGE

255B

Chairs: ***M. Bradford****, Coeur Mining Inc.*
B. Dunn*, RioTinto, South Jordan, UT*

9:00 am

Introductions

9:05 am

Innovations in Geoscientific Data Management at Bingham Canyon Mine

P. Rodriguez and C. White; Rio Tinto, South Jordan, UT

The Bingham Canyon Mine generates vast volumes of geoscientific data from drilling, core logging, sampling, and assaying. This data is critical not only for operational efficiency but also for strategic decision-making across multiple disciplines, including geology, mineralogy, geotechnical engineering, environmental management, and business planning. However, the scale and complexity of this data present significant challenges in terms of accessibility, consistency, and integration. This presentation outlines recent improvements to our geoscientific data management systems, focusing on enhanced data architecture, streamlined workflows, and improved cross-functional accessibility. By implementing centralized data repositories, standardized formats, and automated validation processes, we have significantly improved data quality, traceability, and usability. These advancements have empowered users across departments to make faster, more informed decisions—directly impacting efficiency, productivity, and long-term planning. Our approach demonstrates that robust data management is not just a technical necessity but a strategic asset that underpins critical business outcomes.

9:25 am

Making Block Model Data Accessible in ArcGIS Pro for Single-Pass Mining Applications

A. Kuhn; Mineral Technologies, Saint Simons Island, GA

Traditional block modeling platforms have steep learning curves and are not user-friendly for non-technical users. In single-pass mining scenarios, where rapid, intuitive planning is critical, ESRI ArcGIS Pro offers a practical solution. By compositing block model data over delineated mining intervals, geologic datasets can be created for use in ArcPro. Custom tools and scripts allow users to generate isograd maps and populate polygons with full block model attributes. This approach empowers a broader group—including geologists, engineers, and field staff—to engage directly with spatial geologic data, enabling smarter mine planning and reducing time spent on complex software operations.

9:45 am

Understanding Mineralogical Variability and Its Operational Impacts at the Bingham Canyon Mine

K. Penney; Rio Tinto, Salt Lake City, UT

The Bingham Canyon Mine, located in Utah's Oquirrh Mountains, is a world-class Cu-Mo-Au-Ag porphyry system hosted within a geologically complex setting of intrusive, calcareous, and siliciclastic sedimentary units. This lithological and mineralogical diversity presents significant challenges to downstream operations, i.e., concentration, smelter and refining. Variations in mineralogy across these units can strongly influence key operational parameters, including drill-and-blast performance, grindability, metal recovery, concentrate quality, and equipment wear. To better understand and manage these impacts, blasthole samples from the open pit have been analyzed using automated mineralogy techniques. This presentation will highlight the distinct mineralogical characteristics of key rock types, assess their influence on processing performance, and explore practical strategies for improving downstream operational efficiency through better integration of mineralogical data into operational decision-making.

10:05 am

Rapid Ore Insights: Empowering Ore Body Decisions Through Data Fusion and Machine Learning

S. Kessinger[1], L. Hayes[1], K. Green[1], P. Diwakar[2] and J. Kellar[1]; [1]SD School of Mines and Technology, Rapid City, SD and [2]South Dakota School of Mines and Technology, Rapid City, SD

Laboratory chemical analyses can provide insightful data in all stages of the ore body lifetime. Drawbacks of these analyses are the time and cost associated with data generation. Handheld spectroscopic techniques can provide rapid chemical information. Mobile handheld devices, when used in tandem with machine learning (ML), can rapidly aid in ore analysis. Field operation with handheld spectrometers offers portability and minimal delays. These systems must demonstrate a high level of confidence in the results produced. The demands motivate the development of tools, based on a modern hardware and software stack, which produce fast, reliable results. ML-powered algorithms can be tailored for chemical analyses to meet these requirements. This research demonstrates flexible systems that facilitate the generation of data that rivals benchtop/laboratory analyses. The research fused multiple data streams with four handheld instruments (laser induced breakdown, Raman, near-infrared, and x-ray fluorescence spectroscopies). This spectroscopic data fusion approach offers great promise for improving ore analysis and enables informed decision-making throughout the mineral supply chain.

10:25 am

Artificial Intelligence in Geosciences and How it can Streamline Workflows, and Strengthen the Transfer of Institutional Knowledge for Future Generations

J. Anderson; Dahrouge Geological Consulting, Centennial, CO

There is no secret that Artificial Intelligence (AI) is quickly becoming a cornerstone to modern society. In the mining industry there is hesitation for the proper use of this technology due to its infancy, cybersecurity, or mistrust in the output generated and used by untrained professionals. The use should not be shunned but embraced, with responsible use and validation. As the mining industry becomes more technologically integrated vast amounts of data have and will be collected, and coupling this with a generational shift in the workforce institutional knowledge and mentorship is being lost. AI can help guide junior professionals by enabling and embedding the logic as well as the computational power into their daily work, ensuring the rationale of prior generations can continue to guide and lead scientific reasoning. This presentation will explore how AI platforms can be the institutional memory and guiding force to help enable confidence and increase knowledge into the geosciences. It will also address the understanding and need for cybersecurity as well as give suggestions and guidance on how to properly source data for learning and integration into the workflows.

10:45 am

Syncing the Silos: Interdisciplinary Solutions to Study Stage Challenges

J. Ruffini; Ivanhoe Electric, Bellingham, WA

The mining industry has a track record of isolating mining professionals within silos specific to their areas of expertise, which limits cross-disciplinary collaboration and can have a negative impact on operational outcomes. The Santa Cruz Copper Project Preliminary Feasibility Study released in June 2025 demonstrated a modern underground mine with attractive economics, and serves as a testament to overcoming challenges across various disciplines. We present some of the processes that advanced the Santa Cruz Copper Project through the Preliminary Feasibility Study, highlighting the cooperation between disciplines that contributed to achieving this milestone. Geotechnical, geophysical, geological, hydrological, and metallurgical data were combined to deliver robust solutions to challenging development scenarios. Only through collaboration and cross-disciplinary education were these challenges met, and a favorable study was produced.

11:05 am

Scanning Technologies Workflows: What works in Theory vs. real world

S. Edmond; Professional - Veracio, Murray Bridge, SA, Australia

The rapid evolution of scanning technologies—ranging from sample digitization to advanced x-ray collection and hyperspectral imaging—has transformed workflows across the mining and exploration industry. Yet, organizations often face challenges in selecting and implementing solutions that truly deliver efficiency, accuracy, and sustainability. This paper examines current scanning technology workflows, identifying practices that consistently yield measurable improvements. Through analysis of case studies and comparative frameworks, we highlight what works: integration with cloud-based platforms, automation of metadata capture, adherence to interoperability standards, and user-centered design that maximize productivity and are fit for purpose. Equally important are the overlooked factors—staff training, change management, and long-term digital preservation strategies—that determine whether a workflow remains resilient over time. By synthesizing technical advances with organizational realities, this study provides a pragmatic roadmap for adopting scanning workflows that achieve both operational efficiency and future readiness.

Wednesday, February 25 Morning

MINING & EXPLORATION: GEOSCIENCE: GEOTECHNICAL INNOVATIONS I: SURFACE

250F

Chairs: ***E. Rouleau****, Schnabel Engineering, Marquette, MI*
C. Goss*, Schnabel Engineering*

9:00 am

Introductions

9:05 am

Advancing Geotechnical Cell Mapping Through Hybrid Methods at Rio Tinto Kennecott: A Proactive Approach to Slope Design and Risk Mitigation

J. Soule and C. Hill; Rio Tinto Kennecott, West Valley City, UT

At Rio Tinto Kennecott, the cell mapping program optimizes field data collection by integrating drone-based photogrammetry with traditional field mapping. By minimizing time spent on highwalls, the hybrid method enhances safety while ensuring accurate capture of both structural and intact rock characteristics. Each cell is mapped with the objective of deriving a field-estimated Geological Strength Index (GSI) and assigning structural properties to features identified in the drone models. The process includes photographing and recording observations in a digital workspace to streamline analysis. The implementation of this optimized hybrid cell mapping approach represents a significant advancement in geotechnical practices at Kennecott.

9:25 am

Industry Guidance Note on Observational Mining and Managing Moving Pit Walls

G. Abrahams; BGC Engineering, Kelowna, BC, Canada

An increasing number of mining operations are dealing with deforming pit walls. In most cases such instabilities are unanticipated during the design stage and instead detected through slope monitoring. To safely manage these instabilities and maximize production, the Observational Mining Approach is being adapted at many sites. This approach involves a continuously monitored and adjusted design during excavation to enable safe and economical mining. The challenge is that this approach is often loosely adapted and not well executed which results in poorly managed slopes and operations accepting unnecessarily high levels of risk, or a too conservative approach resulting in NPV loss. A project, sponsored through the Large Open Pit Project (LOP) is to develop a state-of-the-art Guidance Note on Observational Mining. This can be used by eotechnical engineers, mine managers, risk and assurance teams, and managing directors to manage instabilities as they develop at their sites, understand the safety and economic risks, determine if such risk levels are tolerable and develop mining controls and mine plans to manage these risks while maximizing productivity throughout life of mine.

9:45 am

Operational Geotechnical Implementation of Trigger Action Response Plans Using Comparison of Sub-Surface Shear and Measured Surface Deformation of Slope Movements at the Bingham Canyon Mine

F. Schumacher and J. Quijas de Lara; Rio Tinto, Sandy, UT

The paper reviews both the surface and sub-surface monitoring programs for two distinctly different instability mechanisms at the Bingham Canyon Mine. The first area of movement, referred to as the Revere, is a large and deep-seated structurally controlled mechanism moving at relatively low rates of deformation (100-400 mm/yr). This mechanism is governed by a persistent fault structure that extends above 500 m in height. The second area of movement, referred to as the OSR, is a more complex failure mechanism characterized by higher rates of deformation and more dynamic behavior (>15 m/yr). This area is influenced by a combination of geological and operational factors, which result in variable movement rates that require continuous monitoring. Both failure mechanisms are monitored using a combination of surface geotechnical instruments, such as ground base radar, GPS, prisms, photogrammetry, as well as sub-surface methods, including SAAs, and TDRs. The integration of these monitoring systems allows for a comprehensive understanding of the mechanisms, facilitating the development of TARPs to ensure the safety and stability of the mine operations.

10:05 am

An Industry Survey of Current Catch Bench Design Practices: Results and Recommendations

J. McNabb[1], J. Potter[1], S. Warren[2], J. Restrepo[1] and T. Ryan[3]; [1]University of Arizona, Tucson, AZ; [2]Spokane Mining Research Division, Spokane, WA and [3]Call & Nicholas, Inc., Tucson, AZ

Catch benches in open pit mines are critical for rockfall hazard mitigation. However, their design must be balanced with the need for optimal ore recovery. The Modified Ritchie Criterion (MRC) has served as an industry design standard for decades due to its simplicity, relying solely on bench height to determine bench widths. However, the MRC oversimplifies the complexities of rockfall dynamics and does not account for variable rockfall risk and mine production tolerances. For this reason, and a lack of alternative criteria, industry practitioners have adopted a variety of bench design practices to better match site characteristics and requirements. To assess the current state-of-the-industry with respect to catch bench design, the University of Arizona's Geotechnical Center of Excellence conducted a survey of industry experts as part of the NIOSH Highwall Safety Project. The survey focused on identifying these diverse design methods, their perceived limitations, and suggestions for improving future criteria. This study presents the findings of the survey, and offers potential avenues for future research centered on bench design optimization.

10:25 am

Correlation Between Interferometric Radar Data and Geotechnical Instrumentation Systems in Deformation Monitoring

Y. Marin and V. Salinas; Freeport-McMoRan, Clifton, AZ

This study presents a comprehensive evaluation of the correlation between surface deformation data obtained from interferometric radar systems and traditional geotechnical instrumentation, including extensometers, piezometers, prisms, and total stations. The research was conducted at a large-scale mining operation, using data from SSR-OMNI, ArcSAR, and EVO radar systems. The methodology involved temporal and spatial normalization of datasets, time series analysis, deformation rate calculations, and statistical correlation analysis. Predictive modeling and regression analysis were also performed using statistical tools in R. The results demonstrated strong consistency between radar and geotechnical instrumentation data. In several instances, radar systems detected deformation changes earlier than conventional instruments, highlighting their potential for early warning applications. This work provides quantitative evidence of cross-validation between geotechnical monitoring technologies and proposes a replicable methodological framework for data integration in operational contexts. Its analytical and predictive approach contributes to the technical knowledge in stability monitoring.

10:45 am

A Critical Literature Review on Geotechnical Design and Stability in the Transition from Open Pit to Underground Mines

M. SESAY, A. Moradi, Z. Agioutantis, P. Roghanchi and S. Schafrik; University of Kentucky, Lexington, KY

This review synthesizes global practices and case studies to support engineers in managing geotechnical transitions from open pit to underground mining. Key concerns such as crown pillar stability, slope deformation, and subsidence are examined using examples from operations like Chuquicamata and Palabora. Mitigation strategies include engineered backfilling, staged extraction, and stress modeling tools such as FLAC3D and InSAR. Emphasis is placed on geotechnical monitoring and risk-based planning to ensure safety and continuity. The review highlights failure triggers and engineering responses, serving as a practical reference of best practices for technically sound, sustainable transitions in complex mining environments.

Wednesday, February 25 Morning

MINING & EXPLORATION: INNOVATION & TECHNOLOGY: CUTTING-EDGE TECHNOLOGIES FOR SPACE MINING: INNOVATIONS IN EXPLORATIONS AND RESOURCE UTILIZATION

Sponsored by Newmont

255F

Chair: ***I. Casasbuenas Cabezas****, Colorado School of Mines, Medellin, Colombia*

9:00 am

Introductions

9:05 am

Re-engineering Industrial Know-How for Space Resources

S. Salihler; Polimak, Ankara, Turkey

This presentation outlines key points to enable sustainable In-Situ Resource Utilization (ISRU) by adapting decades of terrestrial mining expertise and applying a proven industrial mindset of reliability, efficiency, and scalability to the lunar environment. This involves re-engineering proven terrestrial technologies and inventing new systems to overcome lunar challenges like abrasive dust, extreme temperatures, radiation, and vacuum. Our approach focuses on developing integrated, autonomous systems for the entire regolith (lunar soil) handling chain, including excavation, processing, delivery, logistics, and utilization of final products. This presentation will detail the engineering philosophy for creating the foundational layer of lunar industry. We will showcase examples of terrestrial systems from Polimak Industrial and their associated lunar systems developed by Polimak Space. These systems are designed for reliably handling regolith for the extraction of oxygen, water, and other valuable materials like He3, and for using it as a primary raw material to build infrastructures like landing pads, shelters, and roads, enabling a sustainable presence on the Moon.

9:25 am

Vulcanis: A Multi-Sensor Payload for Real-Time Mineral Prospection

M. Arias-Estrada, L. Richter, T. Nieto and A. Nemirovsky; Vulcanis, Paris, Île-de-France, France

Vulcanis is developing an advanced multi-sensor payload designed to transform mineral prospection through real-time, high-resolution subsurface and surface analysis. The compact, modular system integrates visible/SWIR imaging, LiDAR, and specialized geophysical sensors—such as gravimetry and magnetic field mapping—combined with on-board edge-AI processing for rapid data fusion and interpretation. This approach enables in-field detection of mineral signatures, structural mapping, and volumetric estimations without the need for extensive sample collection or laboratory turnaround. Deployable on terrestrial platforms including UAVs, ground vehicles, and stationary rigs, Vulcanis also offers adaptability for future in-orbit or planetary exploration missions. By merging multi-modal sensing with AI-driven analytics, the platform provides decision-ready information for exploration teams, reducing operational risk, cost, and environmental impact.

9:45 am

Advancing Terrestrial and Lunar Mining Through AI-Driven Autonomous Robotics: The APEX Prototype for Sustainable Resource Exploration

E. Mihoc; Moon Trades SRL, St. Albert, AB, Canada

The mining industry faces persistent challenges in exploration efficiency, safety, and environmental sustainability, exacerbated by outdated technologies and hazardous environments. Moon Trades introduces APEX, an autonomous, legged robotic platform built on Boston Dynamics' mobility framework, integrated with AI for real-time geotechnical analysis, field mapping, and material identification. Designed for both Earth-based operations and lunar resource extraction, APEX reduces human exposure in high-risk zones by over 40%, accelerates data collection by up to 50%, and enhances terrain navigation efficiency by more than 60%, Inspired by off-planet mining constraints, APEX addresses terrestrial bottlenecks such as manual walkdowns, fragmented data, and cultural resistance to automation. For lunar applications, it supports regolith extraction for construction, thermal water ice processing, and helium-3 harvesting, emphasizing the need for precise geological data and step-by-step infrastructure development. By providing verifiable, real-time insights, APEX improves transparency, counters negative public perceptions of mining, and promotes ethical human-robot coexistence.

10:05 am

A Novel Position-Swappable Cooperative Adaptive Control Strategy for Autonomous Surface Mining Vehicles in Planetary Exploration Under Complete System Uncertainty

M. Norouzi[1], M. Zhou[2] and C. Yuan[3]; [1]PhD Candidate, Kingston, RI; [2]Associate Professor, Narragansett, RI and [3]Associate Professor, Kingston, RI

Effective surface mineral mapping in space mining missions demands intelligent, robust, and adaptive control frameworks capable of coordinating multiple mining robots under uncertainty, failures, and dynamic extraterrestrial conditions. This study presents a novel learning-based position-swappable cooperative adaptive control strategy for a team of autonomous surface mining vehicles engaged in coordinated planetary exploration. The proposed framework employs a neural network-based control architecture to adaptively learn system dynamics and terrain variations without prior modeling, while ensuring mission fulfillment. Moreover, the architecture supports modular role-swapping and task redistribution, enabling agents to dynamically compensate for individual vehicle failures and sustain mission objectives. Simulation results validate the framework's performance in achieving high-fidelity surface mineral mapping and adaptive coordination under dynamic extraterrestrial conditions, including its swapping capability, which ensures continued operation despite agent faults, signal latency, and sensor disturbances typical in planetary operations.

10:25 am

26-002

A Machine Learning-Driven Optimization Strategy for Icy Regolith Extraction in the Henson Ridge Crater Chain

V. Tenorio, A. Herrera, A. Khair and N. Risso; University of Arizona, Tucson, AZ

This study presents a machine learning-based strategy to optimize the sequence of icy regolith extraction from a chain of craters west of Shackleton, near Henson Ridge, using autonomous surface mining equipment. The model integrates key parameters—distance, road gradient, vehicle load state, speed, recharge logistics, and regolith water content—into a cost framework covering excavation, hauling, and dumping. Regression models estimate energy and time costs; classification predicts terrain navigability; clustering identifies optimal crater groupings; and K-Nearest Neighbors (KNN) selects efficient routing and scheduling. The system dynamically adapts to a 6-month daylight-only cycle, maximizing productivity while minimizing operational costs. This approach supports intelligent planning for sustained lunar resource extraction under extreme environmental and logistical constraints.

10:45 am

Extraction of Icy Regolith from a Moon Crater Using a Sandwich Belt Conveyor System

M. dos Santos and V. Tenorio; SME, Marietta, GA

Mining at the South Pole of the Moon using a Sandwich Belt conveyor system presents significant challenges. The excavation of icy regolith in a low-gravity environment can be performed with high reliability, thanks to equipment already tested on Earth that provides near-zero reaction force. The Sandwich Belt conveyor system is well-suited for negotiating irregular slopes and efficiently transporting material to the crater rim, even at high angles. However, there are challenges to consider. The harsh lunar environment, including extreme temperatures and abrasive lunar dust, requires robust and resilient equipment. Additionally, the construction and assembly of the conveyor system on the lunar surface will be complex and costly. Estimating production rates, transportation, and assembly costs involves considering the logistics of transporting equipment from Earth. Overall, while the technological and logistical hurdles are significant, the potential for successful extraction of icy regolith using these advanced systems is promising. The case study presented utilizes actual contours from the Moon and a Sandwich Belt conveyor proposed for this unique challenging scenario.

11:05 am

26-050

Provisional Regolith and Megaregolith Zoning Framework for Lunar Construction and Mobility Corridors

R. de Moraes; AECOM USA, Alameda, CA

Lunar construction faces challenges from floaters, boulders, cobbles, and pebbles, scattered across regolith due to impacts. Unlike Earth, the Moon's lack of weathering creates angular, poorly sorted debris, complicating excavation, trafficability, and infrastructure stability. Boulders over 2m block landing zones, while smaller fragments disrupt excavation and installations like solar arrays. This paper proposes a zoning framework for regolith and megaregolith assessment and management during site preparation. Adapting terrestrial methods to lunar conditions, low gravity, no atmosphere, dry regolith, it suggests robotic relocation, dozer displacement, or fragmentation for boulders, and vibratory screening for finer materials. Subsurface floaters risk foundation instability under thermal stress or habitat pressure. Mitigation includes selective excavation and the use of rocks in berms. For ISRU, excavation tools must handle large inclusions. Predictive mapping, orbital imagery, and rover trials guide site selection and hazard avoidance. Viewing floaters as obstacles and resources, this framework enhances safe, sustainable lunar construction.

Wednesday, February 25
Morning

MINING & EXPLORATION: MANAGEMENT: PROJECT VALUATION

255C

*Chair: **M. Stine**, Stantec, Salt Lake City, UT*

9:00 am

Introductions

9:05 am

Benchmarking Mine Design Data from Publicly Available Feasibility Studies

A. Greth, J. Fox and J. Bowling; SRK Consutling, Fresno, CA

Thanks to reporting requirements, technical reports for publicly traded mining companies are available online through company websites and online repositories. With advances in data storage and analytical tools, there is now an opportunity to automate the extraction and comparison of technical information from these publicly available reports. These technical reports contain detailed data on mine site conditions, geology, resource estimation, mining methods, material handling, underground ventilation, processing, cost models, and more. This study applies a Python-based data scraping approach to systematically collect and analyze mine design data across a broad sample of reports. By organizing this information by commodity, mining method, and project context, the analysis enables cross-project comparisons and benchmarking. This study evaluated production rates, pit designs, ventilation parameters, environmental impact, socio-economic impact, and water resources assessments, and more. The resulting dataset provides a valuable reference framework for those developing new feasibility studies or evaluating project viability.

9:25 am

26-030

Evaluation of Mining Project Investments using A System Dynamics Approach

B. Gökçe[2] and O. Golbasi[1]; [1]Middle East Technical University, Ankara, Turkey and [2]Al Masane Al Kobra Mining Co., Najran, Saudi Arabia

Investment decisions in the mining industry are complicated by sector-specific uncertainties. This study presents a multi-submodule system dynamics model to capture the dynamic complexities of decision-making across mineral property development stages. The model includes five interconnected subsystems: valuation, production, growth strategy, demand, and finance. Developed through system decomposition, expert input, and literature, the model is tested on a hypothetical copper mine with 850,000 tpa capacity and 1% grade. Simulated over five years with quarterly steps, it estimates an enterprise value of $78.9 million and a target growth rate of 11.2%. Results highlight the significant effects of operating costs, capital policies, and inflation on free cash flow, and the critical role of mineral reserves in sustaining growth. This model supports strategic investment analysis across different minerals and development phases, offering mining investors a robust tool for optimizing decisions.

9:45 am

Stochastic Finance and Engineering Approaches to Mineral Property Valuation in Inverse Condemnation Claims

J. Moores; Aggregate Appraisals, Flagstaff, AZ

This paper develops a rigorous valuation framework supporting an inverse condemnation claim involving a Colorado hard rock quarry with over 98% diminution in value, consistent with landmark Penn Central and Lucas takings precedents. Proven reserves were verified via core drilling, forming the basis for economic valuation. Advanced stochastic lattice modeling and quantum finance techniques capture commodity price volatility, regulatory risks, and production uncertainties beyond traditional discounted cash flow methods. This risk-adjusted valuation provides a transparent, defendable estimate essential for litigation. The approach integrates mining engineering, mineral economics, and financial modeling in a multidisciplinary framework that addresses the complex challenges of quantifying just compensation under property law.

10:05 am

Improving Mine Valuations Through a Revolution in Financing

G. Geiler; Andorra Capital, Scottsdale, AZ

Mine development faces financing hurdles that can erode valuations due to high financing rates, poor availability, and lack of hedging. Traditional debt and equity fail to mitigate volatility, often requiring costly hedges. A solution involves directly borrowing the commodity itself (e.g., gold) and then repaying the interest in gold itself; thus, embedding hedging into the financing structure. This approach, already embraced by gold and silver miners, refiners, and jewelry manufacturers, grants access to capital from long-term commodity investors, who earn yields on an otherwise idle asset. Its success is unlocking some of the muti-trillion-dollar asset class of underutilized gold.

Wednesday, February 25
Morning

MINING & EXPLORATION: OPERATIONS: LONG RANGE PLANNING AND STRATEGIC OPTIMIZATION

255E

Chairs: ***B. Syers****, South32, Tucson, AZ*
S. Lolon*, Freeport-McMoRan Inc, Phoenix, AZ*

9:00 am

Introductions

9:05 am

Holistic Insights into Uncertainty Based Modelling Approaches for Open Pit Mine Planning

S. AVANE, M. Aghdamigargari, A. Anani and S. Adewuyi; UNIVERSITY OF ARIZONA, Tucson, AZ

Traditional deterministic mine planning models fail to account for geological, operational, and market uncertainties, resulting in suboptimal decisions. This study explores the adoption and effectiveness of stochastic approaches such as geostatistical simulation, discrete-event simulation, stochastic programming, and hybrid simulation-optimization models. Findings show that integrating uncertainties through such techniques significantly enhances robustness, reduces economic risks, and improves decision-making. Fully integrated, large-scale frameworks that merge multi-realization geostatistical orebody models with dynamic equipment-performance simulations and real-time commodity-price scenarios are essential. In addition, algorithms capable of solving such large-scale stochastic and dynamic planning models in near real-time are critically needed to support effective decisions.

9:25 am

Leveraging Process Workflows to Calculate Dilution for Long-Term Strategic Planning

S. David; Amplify Mine Planning, Blainville, QC, Canada

Accurately forecasting stope dilution remains critical for strategic mine planning, yet traditional models often fall short. This presentation introduces a process mapping methodology that leverages advanced spatial analysis and customized workflows to deliver precise, stope-by-stope ELOS dilution and overbreak estimates that improve upon conventional global assumptions to inform long-term strategic planning initiatives. Key outcomes include separation of paste and rock dilution factors, block model estimation of dilution grade, implementation of robust data quality controls, and integration into repeatable and auditable planning templates and workflows. This workflow significantly enhances long-range planning accuracy and supports strategic optimization across underground operations.

9:45 am

26-041

Multi-Lift Methodology for Draw Level Selection in Block/Panel Caving Projects

P. Vergara and J. Barrera; REDCO Mining Consultants, Santiago, Chile

The selection of the production level elevation is one of the most critical strategic decisions in large-scale block or panel caving projects. This choice significantly impacts project timelines, capital expenditures, resource recovery, and may even constrain the maximum production capacity. Over the years, various computational tools have been developed to support this decision, all based on the same underlying concept: maximizing the recoverable value at a given draw level. However, in the case of steeply dipping or vertically extensive orebodies that cannot be mined from a single elevation, traditional level selection techniques using multiple draw horizons often prove suboptimal. This paper presents a methodology to ensure that the selection of draw levels in multi-lift scenarios is globally optimized. The inputs include economic and cost parameters, maximum recoverable column height, and deepening costs. The methodology is demonstrated through a real case study, highlighting its potential impact on overall project value.

10:05 am

26-040

Multicriteria and Modular Approach for the Transition from Open Pit to Underground Mining: De-Risking Concept

E. Rubio and M. Fuentes; REDCO Mining Consultants, Santiago, Chile

The transition from open pit (OP) to underground (UG) mining is a key strategic challenge in modern mine planning. This paper presents a multicriteria, multivariable methodology that integrates technical, economic, environmental, and social aspects, aiming to reduce risk exposure (de-risking) through the identification of alternative development routes, stochastic simulation of uncertainty, and a modular UG implementation strategy. Unlike traditional methods that separate OP and UG planning, this integrated approach leverages synergies between both phases. It defines critical variables (geotechnical, economic, social), builds operational and technological transition paths, and evaluates them by economic attractiveness and practical feasibility. Using SIMPLAN and SIMVAL, probabilistic outcomes and project Value at Risk are quantified. A subsequent multicriteria analysis balances expected profitability and feasibility, producing a decision matrix that prioritizes optimal routes. The study offers strategic guidance for OP→UG transitions that maximize value while minimizing financial and operational risks.

10:25 am

26-007

AMC Hill of Value®: Strategic Mine Optimization and Real Options Analysis at Industrial Scale

T. Pelech, D. du Preez and A. Hall; AMC Mining Consultants, Perth, WA, Australia

Net Present Value from Discounted Cash Flow dominates mining project valuation despite failing to capture managerial flexibility under uncertainty. DCF assumes all risks—volatile commodity prices, geological variability, technical/operational issues—are perfectly priced by markets, an unrealistic premise. Real Options Analysis (ROA) addresses this by valuing managers' ability to defer, expand, scale, switch, or abandon investments as information emerges, capturing upside and mitigating downside. Philosophically superior, ROA routinely uplifts value vs. DCF, but industrial-scale application is crippled by combinatorial explosion in decision trees, Monte Carlo simulations, and models for multiple interdependent/sequential options across zones and periods. The AMC Hill of Value® (HoV) process embraces ROA's core principle—flexibility has value—but operationalizes it via a scalable architecture: parametric relationships, rapid scheduling, and multi-objective evolutionary optimisation. HoV evaluates millions of compound, interdependent real options in one run, yielding resilient, adaptive strategies that preserve flexibility while optimising NPV, mine life, risk, and other objectives.

10:45 am

Semi-mobile in-Pit Crushing and Conveying (IPCC) for Optimized Open Pit Copper Mining: A Production and Cost Analysis

P. Augustine, F. Animah, M. Thille and M. Nichols; Freeport McMoRan, Tucson, AZ

Haulage costs in open-pit mining account for over 50% of total operating expenses, largely due to the truck fleets. This study evaluates the potential of In-Pit Crushing and Conveying (IPCC) systems to reduce these costs through a case study of an open pit copper mine. Using production data, haul profiles, and cost modeling, we compare conventional truck haulage with a semi-mobile IPCC configuration. Results indicate that IPCC systems can offer some haulage cost savings, along with decreased fuel consumption and emissions. However, challenges such as high initial capital investment, reduced operational flexibility, and complex system integration are also discussed. This work offers practical insights and decision-making frameworks for mine planners and engineers considering the adoption of IPCC in similar mining contexts.

Wednesday, February 25
Morning

MPD: CHEMICAL PROCESSING: INNOVATIVE METHODS OF METAL PROCESSING

155E

Chairs: ***I. Penaloza****, Rio Tinto, West Valley, UT*
W. Liu*, University of Utah, Salt Lake City, UT*
W. Hartzell*, Missouri University of Science and Technology, Rolla, MO*

9:00 am

Introductions

9:05 am

Atmospheric Hydrometallurgical Processing of Laterite Ores

S. Choi[1], M. Seo[1], H. Kim[2] and J. Park[1]; [1]Research Institute of Industrial Science & Technology, Pohang, Korea (the Republic of) and [2]Hanyang University, Seoul, Korea (the Republic of)

Nickel has traditionally been used in stainless steel, but demand for high-purity nickel sulfate has recently increased with the growth of the battery market. Laterite ores are a major source of nickel, and hydrometallurgical processes are gaining attention for producing battery-grade nickel sulfate. High-pressure acid leaching (HPAL) is the representative process; however, its high capital cost and environmental concerns, such as tailings dam management, have encouraged the development of alternative routes. In this study, an atmospheric hydrometallurgical process was investigated for the production of mixed hydroxide precipitate (MHP) from laterite ores. The leaching mechanisms were analyzed according to ore type, and a process achieving nickel recovery above 80% under ambient conditions was evaluated.

9:25 am

Demonstrating Selective Gangue Removal from Nickel Sulfide Concentrate in a Continuous Pilot Unit

D. Stigers, K. Radloff, C. Zimmermann, T. Bednarksi, M. Albright and K. Sorenson; Allonnia, Boston, MA

Allonnia has developed a continuous 3-step process called D-Solve™ to remove gangue and penalty elements from nickel sulfide concentrates, which will significantly decrease energy consumption during smelting operations and enable increased recovery during mineral processing. The gangue elements are removed from concentrate via agitated leach with our biosolutions, which are regenerated for continual use, while the removed gangue can be directed into potential new value streams (CO_2 sequestration). The process operated continuously for 5 days, treating 10 kg/day of concentrate, yielding an 18% increase in Nickel grade, a 40% decrease in Magnesium, while removing 20% of the total mass.

9:45 am

Designing Ligand-Functionalized Biochar for Recovery of Rare Earth Elements: A Sustainable Approach to AMD Remediation

W. Tugume, M. Ansari, S. Grushecky, O. Sanyal and D. Talan; West Virginia University, Morgantown, WV

The sustainable recovery of rare earth elements (REEs) from secondary sources, like acid mine drainage, requires adsorbents with high selectivity and stability. Prior batch adsorption studies have demonstrated the need for tailored biochars to facilitate selective recovery of REEs from complex matrices. Preliminary data on anionic polyelectrolyte poly(sodium 4-styrene-sulfonate) functionalized hardwood biochar showed that although the surface charge was shifted from -35 to -47 mV, negligible La(III) uptake was observed. This highlights the need for ligand-accessible binding sites, in addition to facilitating charge-based attractions. This study investigates the design and optimization of ligand coordination functionalization strategies for biochar to facilitate selective REE recovery, and several such strategies will be presented in this talk. The experimental work will be complemented with advanced characterization techniques such as Fourier Transform Infrared Spectroscopy, Brunauer–Emmett–Teller surface area analysis, X-ray Photoelectron Spectroscopy, and zeta potential measurements to assess functional group incorporation, surface charge behavior, and ligand-metal coordination.

10:05 am

Copper Bioleaching in the Prescence of Silver Ions within Column Leaching Experiments

J. Burke[1], H. Johnson[1], K. Webster[2], M. Free[1], X. Yang[1] and E. Owusu-Fordjour[1]; [1]University of Utah, Midvale, UT and [2]University of Utah, Salt Lake City, UT

Copper bioleaching is a process that takes advantage of bacterial activity to assist in copper extraction, particularly in the case of sulfide ores. This research focuses on improving extraction rates via the addition of silver ions. Previous work has shown that silver ions do improve extraction rates, but proof of its viability in an industrial scale heap leach has proven scarce. Our research aimed to address this by performing column leaching experiments to simulate a heap leach scenario. To do this, we prepared silver adapted inoculum via a bioreactor, then agglomerated our inoculum with chalcopyrite ore, and lastly applied leachate to the mixture within a one-foot column for two weeks. We tested multiple conditions including silver concentration within leachate, silver content within agglomerated ore, weight percent inoculum, and leachate application rate.

10:25 am

Pilot Plant Study on Manganese Bioleaching Using Biomass Decomposition Products as a Nutrient Source and Electrolysis for Oxide Precipitation

P. Borkar and T. Eisele; Michigan Technological University College of Engineering, Houghton, MI

Manganese is critical in the steel alloy and battery industries, but the United States has not produced it since 1974. While potential manganese ore deposits are available in the US, mining them with the current technology does not result in a competitive product. This research explores the development and evaluation of a novel in-situ bioleaching process that uses anaerobic organisms and biomass-derived reagents to extract manganese from low-grade ore bodies without the use of purchased toxic chemicals. A pilot plant study demonstrated successful manganese extraction using a mixed-culture of manganese-reducing organisms and fen with organics produced by decomposition of biomass from Typha latifolia, which was fermented to generate organic acids. The resulting manganese-rich leachate was treated using electrolytic oxidation for the recovery of high-purity manganese oxide. This approach achieved over 90% product purity with minimum iron contamination.

10:45 am

Exploring the Use of a Choline Chloride–Based DES Pretreatment to Enhance Gold Recovery from Arsenical Refractory Gold Ores

C. Flores, E. De La Torre and C. Aragón; Escuela Politecnica Nacional, Quito, Pichincha, Ecuador

Arsenical refractory ores limit gold recovery due to high arsenic and iron content. This study evaluates a choline chloride–based deep eutectic solvent (DES) pretreatment (Reline, Etaline, and Oxaline) to selectively remove arsenic and iron, from an Ecuadorian ore (pyrite 15%, arsenopyrite 14%), prior to cyanidation. DES leaching can increase gold recovery from 43% to 63%, demonstrating a promising 20% improvement without roasting. Beyond gold, arsenic removal offers potential for value recovery and environmental benefits. This green, sustainable approach highlights the role of DES in enhancing gold extraction from arsenical refractory ores. Future studies are needed to optimize full-scale application.

11:05 am

A Fluorine-Free Additive for Improved Electrode Quality and Acid-Mist Suppression in Copper Electrowinning Process

K. Amoafo[2], C. Hight[2], Z. Ahmed[2], J. Ruiz[2], N. Makhotla[1] and F. Garcia[1]; [1]Innospec Inc., Tucson, AZ and [2]Innospec Performance Chemicals, Ellesmere Port, United Kingdom

Authors: Kwame Amoafo, Chris Hight, Syed Zaka Ahmed, Joey Ruiz, Nobuzwe Makhotla, Francisco Garcia Key words: Electrowinning, acid-mist suppression, copper, fluorine-free, mineral and metallurgical processing, Health & safety, Environmental The discontinuation of fluorine-based additive used for acid-mist suppression during copper electrowinning presents chemical manufacturers and industry experts a challenge of finding an alternative solution. However, the solutions proposed either generate high foam or adversely affect the electrode quality. In this study, we disclose a non-fluoro, low-foaming additive formulation, purposely designed to suppress acid-mist while maintaining uniform, nodule-free copper deposition. Additionally, its low-foaming property ensures stable process and eliminates interference with downstream operations such as solvent extraction and electrolyte circulation. Laboratory tests demonstrate this additive formulation provides an effective, non-intrusive solution for acid-mist control similar to the fluorine-based surfactant.

11:25 am

Enhancing Copper Extraction Efficiency with Novel Leaching Agents Derived from Mine Tailings

A. Alsafasfeh; Tafila Technical University, Tafila, Jordan

This study investigated the efficiency of a leaching agent developed from mine tailings for copper extraction. The goal was to enhance copper recovery while promoting sustainable mining practices. Copper ore samples were collected, crushed, ground, and sieved, then characterized using XRD, XRF, and ICP. Tailings were processed to produce the leaching agent. Leaching tests were conducted by varying agent concentrations (1–3 M), temperatures (20–60 °C), and durations (60–180 min). Results showed the developed agent achieved up to 92% copper recovery, outperforming a traditional agent which yielded 82%. These findings suggest the developed technique offers improved efficiency and could be scaled for industrial use, supporting eco-friendly resource utilization in mining.

Wednesday, February 25 Morning

MPD: CHEMICAL PROCESSING: SELECTIVE SEPARATION & PURIFICATION

155F

Chairs: ***P. Lin****, Michigan Technological University, Houghton, MI*
Y. Shekarian*, The Pennsylvania State University, State College, PA*
V. Srivastava*, Freeport McMoRan, Tucson, AZ*

9:00 am

Introductions

9:05 am

Advancing Rare Earth Element Recovery from Acid Mine Drainage: A Comparative Study of Ionic Liquid and Conventional Solvent Extractants for Heavy REE Separations

M. Noonan[1], T. Larochelle[2], K. Strickland[2], S. Evans[1], P. Ziemkiewicz[3] and A. Noble[1]; [1]Virginia Tech, Blacksburg, VA; [2]L3 Process Development, Blacksburg, VA and [3]WVU, Morgantown, WV

Acid mine drainage (AMD) is a longstanding legacy environmental issue and one of the major pollutants in many mining districts. Over the last decade, our team has developed and deployed a process for valorizing AMD by recovering and concentrating rare earth elements (REEs). As an REE source, AMD is extremely unique given its exceptionally high portion of heavy REEs, particularly Y, Tb, and Dy, the latter two being critical for high-performance magnets. This unusual, HREE-enriched, REE distribution creates challenges in downstream separation and purification processing when using conventional solvent extraction technologies. To address this challenge, we have explored the use of ionic liquid based extractants and novel styryl phosphonate ester-based extractants tuned for more efficient HREE separation. This presentation will discuss the initial benchtop screening tests and describe pathways for future development and scaleup.

9:25 am

Evaluation of Continuous Membrane-Assisted Solvent Extraction System for Selective Separation of Cobalt from Nickel

K. Kurniawan, A. Cueva Sola, S. Gallagher and T. Dzwiniel; Argonne National Laboratory, LEMONT, IL

In this study, a continuous membrane-assisted solvent extraction (SX) system was used for selective separation of cobalt from nickel. A commercial extractant, bis(2,4,4,-trimethylpentyl)phosphinic acid (Cyanex 272), diluted in kerosene, was used. Synthetic solutions were prepared as working solutions to simulate the actual leaching solutions of black mass of spent lithium-ion batteries. The extraction process was optimized by investigating various parameters, including the flow rates of both aqueous and organic solutions, the concentration of Cyanex 272, initial pH levels, initial concentration of cobalt and nickel, and the number of stages. Following extraction, a small amount of nickel in the loaded organic phase was effectively removed through scrubbing with a diluted sulfuric acid (H_2SO_4) solution. Cobalt stripping from the Ni-free organic phase was studied using the same system while optimizing parameters such as flow rate, initial concentration of H_2SO_4, and the number of stages. These optimized conditions were applied to a real leaching solution derived from black mass, demonstrating the practical applicability of the process.

9:45 am

Recovery of Lithium from Low-Grade and High Na/Li Ratio Solutions Using a Synergistic Extraction System with LIX 54 and TBP

P. Liu, X. Wang and W. Zhang; Virginia Tech, Blacksburg, VA

Low-grade (lithium concentration < 200 mg/L) brines with high Na/Li ratios, such as seawater and produced water, remain underexploited for lithium recovery. This study introduces a synergistic extraction system using LIX 54 and TBP in kerosene, achieving 98.6% lithium extraction from a solution containing 0.1 g/L Li and 75.5 g/L Na (Na/Li ratio = 226.6), with a Li/Na separation factor of 1865. The co-extracted sodium was effectively scrubbed with deionized water, and lithium was fully stripped using 0.5 mol/L HCl. The LIX 54/TBP system demonstrated excellent reusability and stability. Mechanistic analysis identified the extracted complex as Li(LIX 54)(TBP). Compared to other β-diketone/phosphine oxide systems, LIX 54/TBP offers high lithium extraction efficiency, strong Li/Na selectivity, and excellent solubility in diluents. The extraction performance of LIX 54/TBP system was further validated with real produced water. This work provides a promising strategy for lithium recovery from challenging brines and supports sustainable resource development.

10:05 am

Sequential Recovery of Iron and Rare Earth Elements from Coal-Derived Acid Leachate via Dual-Adsorbent Strategy

Y. Pan[1], W. Zhang[1] and R. Honaker[2]; [1]Virginia Tech, Blacksburg, VA and [2]University of Kentucky, Lexington, KY

Acid leachate from coal-based materials (AL) is acidic and enriched with metals such as iron (Fe) and rare earth elements (REEs). Fe is typically present at high concentrations, interfering with REE recovery while also being a valuable resource. To address this, we propose a sequential adsorption strategy for selective recovery of both Fe and REEs from AL using two resins: a Bis-(2,4,4-trimethylpentyl)-based resin for Fe removal and a D2EHPA-based resin for REE separation. Batch experiments were conducted to optimize pH, contact time, and competing ion effects. Fe removal significantly improved REE adsorption efficiency. Column tests confirmed the feasibility of the dual-resin system, with both adsorbents maintaining good regeneration performance over multiple cycles. Mechanistic analyses via FTIR, XPS, and DFT revealed that surface complexation and ion exchange dominate the adsorption process. This approach mitigates Fe interference while enabling co-recovery of critical metals from AL, offering a scalable and sustainable solution aligned with circular economy goals.

10:25 am

Electrochemical Behavior of Impure and Pre-Oxidized Sphalerite in Acidic Media: Implications for Sustainable Zinc Extraction

R. Khodadadmahmoudi[1], S. Karimi[2], H. Abdollahi[3], M. Karimi[4], A. Rezaei[3] and L. Alagha[1]; [1]Department of Mining and Explosives Engineering, Missouri University of Science & Technology, 1400 N. Bishop Ave., Rolla, MO 65409, USA, Rolla, MO; [2]Department of Metallurgy and Materials Engineering, Hamedan University of Technology, Hamedan 6516913733, Iran., Hamedan, Iran (the Islamic Republic of); [3]School of Mining Engineering, College of Engineering, University of Tehran, Tehran, Iran, Tehran, Iran (the Islamic Republic of) and [4]Department of Mining and Metallurgical Engineering, Yazd University, Yazd, Iran., Yazd, Iran (the Islamic Republic of)

Understanding the electrochemical response of mineral impurities is critical for optimizing selective leaching processes in zinc hydrometallurgy. This study investigates the dissolution behavior of five impure sphalerite samples, along with their partially oxidized counterparts, in a 0.5 M H_2SO_4 environment. Partial oxidation was achieved through incomplete leaching using $Fe_2(SO4)_3.H_2O$, producing surface layers enriched in elemental sulfur and metal-deficient zones. Structural and surface analyses (XRD, SEM, Raman spectroscopy) confirmed these transformations. Electrochemical testing revealed that iron-rich sphalerite enhanced current response during cyclic voltammetry, while lead-rich samples exhibited significant passivation. Electrochemical impedance spectroscopy (EIS) showed increased resistance in oxidized samples, further indicating inhibited charge transfer due to surface passivation. These findings provide new insights into the role of trace impurities and pre-treatment strategies in enhancing or limiting electrochemical reactivity. The outcomes offer promising directions for improving the selectivity, efficiency, and environmental performance of zinc extraction processes.

10:45 am

Development of an Ion Exchange Process for the Selective Separation of Rare Earth Elements from Aqueous Solutions

T. Gangadari, M. Rezaee and S. Pisupati; Pennsylvania State University, University Park, PA

Rare earth elements (REEs) are essential for clean energy, electronics, and defense, yet the U.S. remains heavily dependent on imports. This study introduces a sustainable solid-phase extraction (SPE) method using ion exchange resins in a fixed-bed column for group-wise separation of REEs into light (LREEs) and heavy (HREEs) fractions. A mixed REE solution was subjected to adsorption with strong cation exchange and chelating resins, followed by elution using complexing agents such as IDA, NTA, DTPA, and EDTA. One agent demonstrated strong selectivity for HREEs due to higher stability constants, enabling effective group separation. Parameters like pH, complexant concentration, flow rate, bed height, and elution strategy were optimized. Chelating resins outperformed sulfonic acid-based resins, with a maximum adsorption capacity of 37.9 mg/g. Desorption modeling revealed film diffusion-limited behavior (Kf = 0.00001 1/s) for LREEs. Achieving a maximum separation efficiency of 90% for HREEs over LREEs, adsorption followed the Langmuir isotherm, and increasing pH or complexant concentration reduced selectivity. The resins also demonstrated good reusability over multiple cycle.

11:05 am

Evaluation of a Novel, Glycolipid-Based Hydrogel Resin for the Recovery of Metals from Metalliferous Waters

N. Nanayakkara, V. Lokugama, D. Loy, R. Maier and D. Hogan; University of Arizona, Tucson, AZ

Mining processes often contaminate water resources with dissolved metals. In some cases, these metals are critical or valuable, and it may be desirable to selectively recover these elements for economic and environmental benefits. One common approach for such recovery is the use of adsorbents, but the efficacy, selectivity, and economy of adsorbents vary widely. Environmentally-friendly glycolipid surfactants selectively bind metals such as uranium and the rare earth elements, but their use in adsorbent materials is limited. In this study, we develop a hydrogel resin with glycolipid surfactants as the metal-capture group and evaluate its performance using lead and uranium. Using model lead solutions, the effect of pH, metal concentration, reaction time, and presence of competing ions on lead adsorption were tested to characterize the resin's performance as an adsorbent. The sorbent was then tested in a real-world groundwater impacted by uranium mining to demonstrate the potential of this material for remediation of mining-influenced waters.

11:25 am

Advancing Lithium Recovery: Evaluation of Electrodialysis, Capacitive Deionization, and a Novel Hybrid Electrochemical System

S. Huanca and C. Anderson; Colorado School of Mines, Golden, CO

Lithium extraction is of increasing global importance due to rising demand and resource limitations. Lithium occurs in natural brines and minerals containing high levels of impurities, which complicate selective recovery. Conventional methods often struggle to separate lithium efficiently, while also generating hazardous waste and consuming large volumes of water. This project investigates electrochemical techniques for direct lithium extraction, targeting the production of lithium hydroxide (LiOH). Electrodialysis (ED) and Capacitive Deionization (CDI) are evaluated to optimize operating conditions, and both methods are integrated into a hybrid system designed to improve efficiency and adaptability. The study supports the advancement of scalable, environmentally sustainable and responsible alternatives for lithium recovery from complex sources.

11:45 am

Ionic Liquids in Leaching and Solvent Extraction of Rare Earth Elements from Coal Based Sources

E. Guney, B. Ji and R. Honaker; University of Kentucky, Lexington, KY

Ionic liquids are room temperature molten salts which are composed of organic cation and organic or inorganic anion. Their low vapor pressure, high thermal stability and non-flammability make them safer and greener alternatives for conventional solvents. The growing demand for rare earth elements has necessitated a shift in focus toward secondary sources as alternatives to primary sources. In this study several ionic liquids were synthesized for leaching and solvent extraction processes. Synthesized ionic liquids were tested for leaching rare earth elements from coal based sources. The synthesized ionic liquids for the solvent extraction were evaluated for their efficiency and selectivity in rare earth element solvent extraction systems. Key parameters such as pH, ionic liquid concentration, and aqueous to organic ratio were optimized.

Wednesday, February 25
Morning

MPD: COMMINUTION: COMMINUTION II

155C

Chairs: ***K. Asgari****, PhD student in West Virginia University, Morgantown, WV*
E. Kaykay

9:00 am

Introductions

9:05 am

Next Leap in HPGR Flowsheet Design

B. Dierx, R. Van Rijswick, R. Oliveira and E. Licares; Weir, Venlo, Netherlands

The paper presents advancements in HPGR-based comminution circuits and reports the value proposition and limitations for adopting multi-staged HPGR circuits, combined with innovative (dry) classification and beneficiation opportunities. Supported by operational data and poses conceptual ideas for future improvements. The operating bandwidth of the HPGR technology has been continuedly stretched in terms of single stage size reduction. These high, single unit loads do impact the operability and the grinding and classification efficiency on any comminution device, which validates research on finding CAPEX and OPEX harmony whilst distributing these loads across multiple stages. Previous work by Van der Meer [5] discussed several multiple pass HPGR arrangements and provided commentary on its respective technical suitability and balance of CAPEX and OPEX. In this work, pilot data is being presented for different innovative single and multiple stage HPGR flowsheet configurations as well as for HPGR circuits producing multiple intermediate and/or final products.

9:25 am

Ten Essential Items Every Metallurgist Should Know About SAG Milling Circuits

B. Cornish; ME Elecmetal, Point Lonsdale, VIC, Australia

Semi-Autogenous Grinding (SAG) milling circuits are central to most mineral processing operations, offering high throughput and operational flexibility. However, their complexity demands a deep understanding of both metallurgical principles and operational nuances to optimize performance and ensure reliability. This paper outlines ten essential items every metallurgist should know to effectively operate and troubleshoot SAG milling circuits. Topics include ore characteristics and variability, mill charge dynamics, design power draw, liner design and wear, grinding media selection and daily charging, classification efficiency, control strategies, instrumentation and data analytics, balancing the circuit, and common failure modes. Each item is discussed with practical insights, backed by case studies and industry benchmarks, to provide a comprehensive guide for metallurgists aiming to enhance circuit efficiency, reduce downtime, and improve overall plant economics. This paper serves as both a foundational reference and a practical toolkit for professionals engaged in SAG milling operations.

9:45 am

Improving Mill Throughput via Optimized Magnetic Liner Design

X. Jiang; Eriez Manufacturing Co., Fairview, PA

The Magnetic Mill Liner (MML) represents a significant advancement in grinding mill lining technology, offering superior durability and operational benefits compared to conventional steel or rubber liners. MMLs typically last two to four times longer, resulting in increased mill availability, reduced maintenance costs, and improved overall efficiency. A critical factor in MML design is liner thickness, which must be optimized to balance wear life with grinding power, given the power's proportionality to the mill diameter. At the Karara mine, an MML was installed in one of four ball mills. While the traditional steel-lined mills have an internal diameter of 6,150 mm, the MML design achieved a slightly larger diameter of 6,178 mm. After four months of operation, the MML-equipped mill demonstrated substantial performance improvements: a 3-micron reduction in P80, increased throughput from 561 tph to 638 tph, a 6.97% reduction in specific power consumption, and a 3% decrease in recirculating load to 28%. Importantly, the optimized liner thickness enabled a projected service life of 7 years—approximately 3.5 times longer than that of the steel liners.

10:05 am

AI-Based Sensor Sorting of Grinding Balls from Magnetized Aggregate

F. Hottenstein; MSS, Inc., Nashville, TN

Sorting of grinding balls from magnetized aggregate is a challenge and one of the few tasks left in a modern processing facility that may still mostly be conducted manually. MSS developed a technology that uses Artificial Intelligence (AI) to detect and classify "Grinding Balls" from "Magnetized Rocks" and automatically separate them using selective electro-magnets. Recent advances in AI allow performing the above classifications with clear distinctions and exceed human performance, using deep-learning algorithms that are based on 100,000's of data set. They extraction of heavy grinding balls poses several challenges: weights of up to 25lbs, 3D shape and high bulk density make it very difficult to use either air-jets or robots. Robots have the main disadvantage of being limited to a certain number of picks per minute. MSS developed an extraction solution where selective electro-magnets positioned across the width of a conveyor can be individually activated whenever a "Grinding Ball" is detected. This selective electro-magnet activation alters the trajectory of the "Grinding Balls" away from natural trajectory of the "Magnetized Rocks".

10:25 am

AI-Driven Optimization of Energy Consumption in Clinker Grinding Using Gradient Boosting and SHAP Analysis

J. González Guzmán[1], O. Restrepo Baena[1], J. Menendez-Aguado[2] and M. Bustamante[1]; [1]Universidad Nacional de Colombia, Medellín, Antioquia, Colombia and [2]Universidad de Oviedo, Mieres, Asturias, Spain

This study developed a predictive model using Gradient Boosting Regressor to estimate power consumption in clinker grinding at a Colombian cement plant. The model achieved a strong performance with an R2 of 0.91, demonstrating high predictive accuracy. Through SHapley Additive Explanations (SHAP), the most influential factor was identified as the clinker feed rate. The analysis enabled the definition of optimal operating ranges that reduce energy consumption below 26 kWh/t, while ensuring cement strength remains above 24 MPa. These results provide a robust, data-driven strategy for enhancing energy efficiency without compromising product quality in the cement manufacturing process.

10:45 am

Lowering CO2 Emissions in Iron Ore Operations: Updated Findings on Wear Part Optimization in Cone Crushers

T. Veneroso[1], B. Klein[2], S. Miskovic[2], M. Bergerman[3] and P. Radziszewski[4]; [1]Am Cast Inc, Bohemia, NY; [2]University of British Columbia, Vancouver, BC, Canada; [3]Escola Politécnica Universidade de São Paulo, Cidade Universitária, São Paulo, SP, Brasil, Brazil and [4]Rampart Detection Systems, Langley, BC, Canada

Comminution consumes 30–50% of a mine's electricity, with higher shares in low-grade ores. While grinding dominates, crushing—especially cone crushers—plays a critical but often overlooked role in energy and emission analyses. Most LCAs focus on Scope 2 power use, neglecting Scope 3 impacts from wear-part production, logistics, and replacement. This study introduces an integrated Scope 2 + 3 LCA model applied to four North American iron-ore sites. Results show that replacing manganese liners (0.267 kg CO2/t) with MNX liners (0.077 kg CO2/t) across 37.4 Mt saved 7,111.5 t CO2e (≈ $142k at $20/t). At some mines, wear parts contribute up to 35% of crusher-related CO2e. The model's modules—Scope 2 (power use), Scope 3 (wear parts), and benchmarking—normalize results per tonne processed. A new Wear Part Efficiency Index (WPEI = tonnes processed/kg liner) links sustainability to performance, with MNX doubling or tripling WPEI. Beyond iron ore, the method applies to aggregates and recycling, enabling equipment-level ESG reporting and aligning maintenance choices with decarbonization goals.

11:05 am

Enhancing Chalcopyrite Liberation and Flotation Performance through CO_2-Assisted Grinding

Y. Wang[1], X. Wang[1], W. Zhang[1] and R. Honaker[2]; [1]Virginia Polytechnic Institute and State University, Blacksburg, VA and [2]University of Kentucky, Lexington, KY

Different minerals within the same ore respond differently to CO_2 exposure, potentially leading to the formation of internal defects and microcracks within ore particles. These structural changes can affect ore grindability, the degree of target mineral liberation during comminution, and ultimately impact subsequent flotation performance. Given this, the authros initiated a comprehensive experimental program to evaluate the effects of CO_2 treatment on the grindability and flotation performance of chalcopyrite. The results indicated that CO_2 treatment significantly reduced the ore's mechanical strength, leading to improved grindability and a marked enhancement in target mineral liberation. Notably, CO_2 treatment reduced chalcopyrite losses to tailings by over 40%. This study provides valuable insights for reducing energy consumption in grinding and improving overall mineral processing efficiency. Furthermore, it highlights a novel application pathway for carbon mineralization technologies, offering a promising approach to advancing more sustainable mining practices.

Wednesday, February 25
Morning

MPD: FLOTATION: SPECIAL SESSION IN HONOR OF JAN MILLER

155D

Chairs: ***P. Chu****, University of Nevada, Reno, Reno, NV*
S. Merrill*, FLSmidth USA Inc, FLSmidth, Salt Lake City, UT, Midvale, UT*

9:00 am

Introductions

9:05 am

Rare Earth Beneficiation: Insights from Recent Case Studies

J. Liu; SGS Canada, Lakefield, ON, Canada

Rare earth elements (REEs) play pivotal roles in modern technologies, particularly clean energy and defense applications. This paper presents a compilation of recent case studies focused on rare earth beneficiation, including flowsheet development, laboratory trials, and pilot plant operations. The studies explore a range of techniques including froth flotation, magnetic separation, and gravity separation. Various mineralogical compositions – ranging from bastnaesite and monazite to xenotime and allanite – are examined alongside their associated gangue minerals such as calcite, dolomite, ankerite, silicates, and iron oxide. The objective is to provide insights into REE responses under diverse technological approaches, highlighting the influence of mineralogical composition and texture on their extraction efficiency.

9:25 am

3D Characterization of Coarse Particle Flotation Samples of Copper Ore for Exposed Sulfide Grain Surfaces

J. Jin[1], J. Liu[1], A. Vanstaden[2] and C. Lin[1]; [1]The University of Utah, Salt Lake City, UT and [2]Teck Resources Limited, Trail, BC, Canada

The liberation and exposure of valuable mineral grains in ore particles are important in understanding the efficiency of flotation separations. Coarse particle flotation technology benefits from the more stable bubble-particle attachment and can float ore particles with limited exposure of hydrophobic phases. A flotation concentrate and a flotation tail from a pilot-scale coarse particle flotation test were scanned by micro X-ray computed tomography (micro-XCT) at the voxel of 5.2 um using a Xradia-400 system. Trainable Weka segmentation, a machine learning method, was applied to improve segmentation of selected particle size fractions. The exposure analysis of sulfide grains in concentrate and tail suggested particles with about 5% sulfide grain surface exposure can be reliably collected by this coarse particle flotation technology. The liberation analysis of this bulk sulfide flotation was consistent with the exposure results.

9:45 am

Chatoci Mixing Performance in Flotation Process with Multishaft Stirred Tank

z. Liu; Chongqing University, Chongqing, Chongqing, China

Flotation process and its enhancement mechanisms in multi-shaft stirred reactors still faces challenges that limit its industrial applications.RNG k-ε model was used to numerically simulate the solid-liquid mixing process within a multi-shaft stirred reactor, yielding satisfactory results compared to experimental data. Solid-liquid mixing performance under four different operational conditions reveals that applying variable speed conditions to the bottom impeller results in a smaller solid concentration gradient, reduced particle settling rates, and an improvement in solid homogeneity by 2.74% to 3.22% compared to other operational conditions. Flow field analysis under different operational conditions indicates that applying variable speed to the bottom impeller significantly improves flow field stability, reduces axial back-mixing, and optimizes the axial distribution of solid particles. Further DMD of the flow field and time series analysis of modal coefficients elucidate a multi-scale synergistic nesting mechanism characterized by "macroscopic stability, mesoscopic matching, and microscopic resonance."

10:05 am

Probing Ligand-Mineral Interactions via Contact Angle Distributions

N. Bellusci, R. Farinato and D. Nagaraj; Columbia University, Stamford, CT

Contact angle is a well-recognized and important parameter in characterizing the water wettability of mineral surfaces relevant to flotation. However, contact angles are commonly reported as single average values and measured under conditions not relevant to flotation plant practice. These data are inadequate and ignore the fact that even flat-polished surfaces of "pure" minerals can possess significant surface heterogeneity, not to mention conditions on real ore particles. We established a practice of measuring several hundred contact angles at multiple locations across select mineral surfaces, using a variety of collector ligands under conditions and concentrations relevant to plant practice. Contact angle distribution data provides a more meaningful method of characterizing ligand adsorption, mineral wettability and surface heterogeneity. We discuss the importance of contact angle hysteresis, mineral hydration, critical differences between sessile water droplet and captive bubble contact angles, and how subtle molecular level changes in ligand structure can dramatically change the hydrophobicity imparted to a mineral surface.

10:25 am

26-019

Cyanide-Free Processing Circuits for Gold Ores with High Pyrite and Arsenopyrite

J. Milbourne[2] and M. Fan[1]; [1]Eriez Manufacturing Co., Erie, PA and [2]Troilus Gold Corporation, Toronto, ON, Canada

Cyanide is widely used in the flotation of gold ores to depress pyrite and arsenopyrite, which can cause difficulties during the beneficiation due to its natural tendency to float with gold minerals. Depressants like cyanide played a crucial role in preventing pyrite and arsenopyrite from being floated. Cyanide was commonly used to depress these minerals however due to environmental concerns, its use was replaced with other non-toxic reagents. The process of extracting gold from gold ore flotation concentrates or gold ores, specifically through a technique called cyanidation or cyanide leaching. This method utilizes a dilute solution of cyanide to dissolve gold from the ore. While effective, the use of cyanide raises environmental and safety concerns. This has led to the exploration of alternative, environmentally friendly reagents. This paper will discuss processing results using the alternative depressants such as Na2SO3, CaO, and Na2CO3 for ores where arsenopyrite and pyrite are not gold bearing to produce a gold-rich flotation concentrate for sale to a smelter or as feed to an alternative leaching agents and methods to extract gold from ore without relying on cyanide.

10:45 am

Understanding Colloidal Behavior to Address Filtration Challenges in Cu/Mo Thickeners

M. Sime; Freeport McMoRan Inc., Bagdad, AZ

This industry-based investigation explores the application of colloidal science—specifically zeta potential and particle size distribution (PSD)—to better understand and address filtration inefficiencies and persistent froth formation in copper/molybdenum (Cu/Mo) thickening circuits. A series of controlled tests were conducted on process samples to evaluate surface charge behavior across a range of pH conditions and to identify fine particle fractions associated with filtration challenges. Complementary filter cloth trials were performed under varied chemical and operational conditions. While specific results remain confidential, the study demonstrates how fundamental insights into colloidal behavior can inform practical strategies for improving filtration performance and managing froth-related disruptions in mineral processing environments.

11:05 am

Advances on Flotation of Copper Tailings

A. Videla; Pontificia Universidad Catolica de Chile, Santiago, Chile

As copper grade of current deposits declines, the amount of tailings production for the same copper production is expected to rise. Reprocessing of material from tailings dams is not only environmentally desirable, but also increasingly economically feasible as head grades of old tailings can be high compared to new deposits. Flotation tailings, however, usually contain a large proportion of fine (10–50 m) and ultra fine (<10 um) material and the effect of these particle sizes on fluid flow conditions and froth stability is not yet fully understood. This work shows efforts on the caracterization of copper tailings and evaluation of its flotation performance under controlled conditions. The result shows the effect of particle size distribution on fluid flow conditions and froth stability. Finally, it is shown how operational conditions strategies could decrease the negative effect of the fine and ultrafine presence and enhance flotation. These findings also have important implications for the reprocessing of copper tailings.

11:25 am

Surface Forces in Foam and Emulsion Films

M. Gupta and R. Yoon; Virginia Tech, Blacksburg, VA

A Scheludko-Exerowa cell was used to monitor the changes in curvature associated with the interactions between two air bubbles and two drops of hydrophobic solvent (toluene) in water. The results obtained at different temperatures (10-20°C) and NaCl concentrations were analyzed to determine the disjoining pressure isotherms (Π(h)) and the free energy changes (ΔG). The results showed that the stabilities of foam and emulsion films are controlled by enthalpy rather than entropy, which is contrary to what is known for the hydrophobic interactions at the molecular scale. Also, the ΔG values were small due to significant enthalpy-entropy compensation. Implications of these findings on flotation will be discussed.

Wednesday, February 25
Morning

MPD: PLANT DESIGN: PLANT DESIGN & OPTIMIZATION II

Grand Blrm D

Chairs: ***K. Miles****, Auramet*
G. Bermúdez*, Metso Canada Inc, Burlington, ON, Canada*

9:00 am

Introductions

9:05 am

Hermosa: Adventures in Design Evolution

M. Novak and A. Watt; South32, Tucson, AZ

South32 is developing Hermosa's zinc/lead/silver sulfide Taylor deposit in southern Arizona with a targeted initial production of zinc and lead concentrates in 2027. Site infrastructure is rapidly advancing with both the main and ventilation shafts sinking and processing plant construction underway. With operations less than two years away, let's reflect on the project's evolution to date. Is the project plan conceptually the same? What changed and for what reasons? This presentation will walk through the challenges and opportunities that arose during studies, engineering, and governance and has led to what South32 is proud to be building today.

9:25 am

Preventing Gold Losses by Improving Gravity Circuit Performance

E. Buck; Hecla, Coeur d'Alene, ID

Challenged with an ore body including both free coarse gold and finely disseminated single and double refractory gold in varying amounts throughout the deposit, the process team at this mine site worked to increase gold recovery while the deposit faced lower head grades over the course of the mine plan. This was achieved through a series of process optimizations meant to push the recovery of free coarse gold forward in the process to the gravity circuit, outside the reach of preg-robbing carbon and cyanide-consuming host rock minerals. Improvements included modification of the grinding circuit classification systems to increase and improve gravity circuit feed, plant trials of various gravity concentrator operational parameters to improve gravity circuit recovery, and accommodating for capacity increases downstream in the intensive leach reactor and electrowinning cells. Recovery by gravity increased by approximately 5 percent with the modifications in place.

9:45 am

A Methodic Approach to Optimize Process Control Assets Performance and Reliability

M. Tardif; BBA, Sandy, UT

As part of a broader initiative to enhance operational efficiency, a processing plant implemented an audit and optimization project for its process control. The project focused on improving the performance of over 3,500 field devices and hundreds of PID control loops using cloud-based survey and data reconciliation tools along with loop performance monitoring (CLPM) software. The audit revealed numerous mechanical and tuning issues, enabling targeted upgrades and predictive maintenance. This paper demonstrates how efficient remediation and upgrades of process instrumentation can be achieved by performing a thorough survey of all process sensors, actuators, and controls. Examples will show how advanced analytics tools like power spectrum and cross correlation helped isolate root causes of instability, leading to significant improvements in control, energy savings, and asset longevity.

10:05 am

26-005

Adaptive Automatic Control Strategy for High-Rate Thickeners Under Variable Tailings Conditions

J. Sierra[2], S. O'Brien[3], R. Williams[4], C. Mejias[1] and E. Godoy[1]; [1]Hibring, Concepcion, Biobio, Chile; [2]McLanahan Chile, Santiago, Chile; [3]McLanahan USA, Hollidaysburg, PA and [4]McLanahan Australia, Newcastle, NSW, Australia

High-rate thickeners play a critical role in tailings management by enhancing water recovery and increasing solids concentration. However, these units face operational instability due to fluctuations in feed solids, flow rate, and flocculant response-typically managed in manual mode with delayed corrective actions. This work presents an adaptive automatic control algorithm designed for dynamic thickening environments. The algorithm integrates real-time measurements of feed density, rake torque, bed level, and turbidity (overflow), optimizing the underflow slurry density while minimizing suspended solids in the overflow. Preliminary validation using a pilot-scale thickener with synthetic tailings showed noticeable improvements in process stability and faster operational response under varying feed conditions. The proposed control strategy is modular, scalable, and applicable to both existing and new thickening systems, offering a robust alternative to manual operation in increasingly demanding metallurgical environments.

10:25 am

A Diamond in the Rough(er): Case Studies of the Jameson Cell in Roughing and Scalping Duties

R. McKechnie; Glencore Technology, Brisbane City, QLD, Australia

Many mineral processing plants seek to increase throughput and optimise their existing Brownfields operations to increase recovery. However, the required changes are often constrained by footprint. The Jameson Cell is a high-intensity flotation device capable of recovering particles across a broad size distribution (beyond that of conventional flotation cells) due to a combination of small bubble size and intense mixing. These are facilitated by the design of the cell's slurry distribution system, which also creates an environment for bubble particle collisions to occur in seconds, negating the requirement for design based on residence time and allowing a single Jameson Cell to replace multiple tank cells. While the origins of the Jameson Cell lie in cleaning, it's benefits in roughing and scalping duties have become clear, resulting in as many Jameson Cells being in installed in these duties in the last four years as had been installed in the thirty years before that. This paper presents case study results of recent Jameson Cell retrofits for roughing/ scalping in brownfield processing plants, highlighting the significant potential of the cell in optimising existing circuits.

10:45 am

New Advanced Electrolytic Technology Yields Higher Production Density than Convectional Technology

P. James; Blue Planet Strategies, Madison, WI

Production density (PD) quantifies product throughput in terms of footprint area and is a useful metric when facing space or mobility constraints. Higher PD generally means equipment is smaller, easier to move or mobilize, and often lower-cost to install in terms of currency/mass product-unit time. High PD DeMet technology is examined and compared to conventional plate and frame electrowinning technology commonly deployed at many copper production facilities. Selected footprint and economic considerations will be compared for representative scenarios. Potential application and benefit for space constrained facilities or smaller-scale and difficult to exploit ore bodies into production will be examined.

11:05 am

Restart and Modernization of Milford Mining Operations: Process Innovations Driving Throughput, Efficiency, and Product Quality

B. Fistrovic; Milford Mining Company Utah, Milford, UT

After a multi-year shutdown, Milford Mining Operations underwent a strategic restart with a focus on resolving past performance issues. A major enhancement was the installation of a Vertical Shaft Impactor (VSI) in the tertiary crushing circuit, which removed a key throughput bottleneck and boosted mill capacity. Acid consumption improved significantly—from 311 lb/ton in 2018 to 167 lb/ton between April and August 2025—reflecting better acid management and leaching efficiency. In the CCD circuit, new dilution pumps lowered feed density, improving wash efficiency and reducing copper and acid losses. Further process improvements included separating high- and low-grade streams in the solvent extraction circuit to enhance acid utilization and reduce copper in wash water. Upgrades to OTG filtration systems improved reliability and electrolyte recovery. Nine electrowinning cells were converted to polishing duty to prevent organic carryover, and electrolyte flow was increased and redistributed for greater efficiency. These targeted changes demonstrate the value of modernizing legacy assets through data-driven process improvements.

Wednesday, February 25
Morning

RESILIENT ENERGY IN MINING: BALANCING TRADITION AND TRANSFORMATION: FROM PERMITTING TO PRACTICE: INNOVATIONS AND STRATEGIES FOR DECARBONIZED, DIGITAL, AND NATURE-POSITIVE MINING

Grand Blrm B

Chair: ***A. Patel****, Barr, Salt Lake City, UT*

9:00 am

Introductions

9:05 am

Scalable Strategies for Decarbonizing Mining Fleets

R. Bhattacharjee; GHD, Toronto, ON, Canada

A major mining client sought decarbonization pathways for four industrial sites in the Atlantic region—Vaudreuil, Saguenay Lac St-Jean, Kitimat, and Iceland—each with diverse mobile fleets. Key challenges included high power demands, specialized off-road vehicles, and complex change management. A five-step assessment evaluated technology readiness, commercial and technical viability, financial impact, and operational implications. Baseline GHG emissions and energy needs were established, and a market scan identified decarbonization workstreams like fuel switching, battery electric, hydrogen, and natural gas. Each was assigned a Technology Readiness Level (TRL). Workshops helped prioritize projects, each analyzed for constraints, risks, and opportunities. Scenarios—lowest cost, lowest risk, fastest implementation—were modeled to forecast financial, environmental, and operational outcomes. The result: tailored roadmaps that balance emissions reduction with operational and financial feasibility, offering a scalable model for the mining sector.

9:25 am

Mining Forward, the Potential for Lower Emission Mining Operations

A. Hattersley; ExxonMobil, Angmering, West Sussex, United Kingdom

The mining sector is essential to modern life. The sector's unique day-day demands of responsible, safe, efficient and productive operations are increasingly joined by the emerging inter-lined challenges of replacing depleting resources, the development of new skills and capabilities (data integration, automation & electrification), and a drive to reduce operational emissions. Attendees will hear insights from research of mining operators on the challenges they face, the practical pathways they are navigating to lower emission mining operations, what is driving that focus, the emerging choices and the barriers they are seeking to overcome. This will be complemented by ExxonMobil's own experience as a sector solution provider & operator, together with success stories including the potential to tap further productivity and efficiency gains and the emerging role of renewable diesel in haul truck operations.

9:45 am

Energy and Air Quality Permitting Strategies to Integrate Novel Technologies for Mining and Mineral Processing Facilities

A. Patel; Barr, Salt Lake City, UT

Energy is fundamental to mining and mineral processing and, therefore, critical for infrastructure, technological advancement, economic growth, public welfare, and the environment. This abstract explores New Source Review permitting strategies by providing hypothetical case studies specific to the mining and mineral processing industry. The current landscape of the Clean Air Act is dynamic and complex, which affects the length of time before a permit can be obtained. The focus of these case studies will be on how to integrate emerging technologies into permits for mining and mineral processing facilities. This conjecture will detail strategies on how to replace emergency power with a solar and energy storage system, and how to meet steam demand by replacing combustion of natural gas with a small modular nuclear reactor.

10:05 am

Transforming a Legacy Coal Mine into a Sustainable Energy Production and Storage Facility

B. Saffron; GHD, Calgary, AB, Canada

The Tent Mountain Renewable Energy Complex development is a novel, real world approach to re-imagining and then physically re-purposing an idle coal mine. It takes advantage of natural topography and previously disturbed areas, market and political support for both clean hydrogen fuel and a grid stabilizing energy storage system. The development is one that achieves many objectives across Indigenous, social, political, environmental, and energy transition elements. Importantly, it is a both financially viable and technically feasible decarbonization. It is a compelling transformation that is an example of what is possible when multiple, diverse skills and thinking are brought together to solve a complex challenge of transforming a legacy mine. In the presentation, we will share technical and commercial considerations that occurred when exploring how to convert Tent Mountain into a renewable energy storage facility capable of powering 400,000 homes for up to 15 hours.

10:25 am

Making Nature Visible in Mine Planning Using Digital Twins - A Tropical Case Study

D. Anderson[1], K. Dagdelen[1], A. Kerr[2] and J. Norro[2]; [1]Colorado School of Mines, Lakewood, CO and [2]Hexagon R-evolution, Stockholm, Sweden

Using Lidar to generate terrain models for mine planning is a common industry practice in which the survey points representing vegetation are filtered out and seldom used. However, other industries use these points to characterize forest structure, monitor crop growth, and derive ecological metrics. We will show how these conventional methods to estimate biomass can be leveraged with other sophisticated nature monitoring solutions to distill complex biodiversity data into a format mining engineers can use to design for nature positive outcomes. This work marks the first stage in an academia-industry collaboration to bring biodiversity metrics directly into the mine planning workflow. Using a case study in a tropical forest setting, we demonstrate how the Green Cubes Digital Reality platform can support carbon and biodiversity offset strategies, rehabilitation planning, and ESG reporting requirements of mining operations.

Wednesday, February 25
Morning

TAILINGS MANAGEMENT: GROUND TRUTHS: WHERE TAILINGS RISK MEETS GISTM AND REGULATION

Sponsored by Newmont

155B

Chairs: ***A. Kalmes****, Barr Engineering Co, Minneapolis, MN*
T. Walkenbach*, WSP USA Inc., Creve Coeur, MO*
C. Winter*, Cleveland-Cliffs, Inc., Hibbing, MN*

9:00 am

Introductions

9:05 am

Thinking about the GISTM? Challenges to Expect on Your Journey from Good to Great

L. Carr and N. Nguyen; Ramboll Americas Engineering Solutions, St. Louis, MO

The Global Industry Standard for Tailings Management (GISTM) was promulgated in 2020. Members of the International Council of Mining and Metals (ICMM) committed to GISTM conformance at their tailings facilities (TFs) by August of 2025. Non-ICMM members have either adopted the standard, planning future adoption, taking a "wait and see" approach, or have decided against adoption. While GISTM adoption has many benefits – for the owner, society, and the environment – it is a multi–year process that requires the owner to dedicate significant staff and financial resources. It is not uncommon for a modern, well-designed, well-managed, and low risk TF to have dozens of GISTM conformance gaps, requiring hundreds of thousands of dollars to address. This presentation is intended for TF owner/operators who already have "good" tailings facilities and are either considering or in the early stages of making them "great" via adoption of the GISTM. It will provide a high-level overview of common conformance gaps owners/operators should expect, and the challenges they may encounter in both closing those gaps and developing a holistic tailings management system (TMS).

9:25 am

26-060

The Johnstown Flood of 1889: Historical Context and a Review of What Could Have Changed with Current Risk-Informed Decision-Making Applications

A. James and C. Sandhu; NewFields Canada Inc., Saskatoon, SK, Canada

This paper examines the catastrophic Johnstown Flood of 1889 through both historical and contemporary risk management lenses. The disaster, which claimed 2,209 lives when the South Fork Dam failed, resulted from inadequate spillway capacity, poor maintenance, removal of outlet pipes, lowering of the dam crest, and installation of fish screens that impeded flow—all occurring within a context of limited regulatory oversight. When viewed through modern Risk-Informed Decision Making (RIDM) frameworks such as that proposed by USSD and CDA (2024), the disaster illustrates critical gaps in dam safety management. Contemporary RIDM processes—integrating technical risk assessment with societal values, economic factors, environmental impacts, and stakeholder engagement—would have fundamentally altered decision-making around the South Fork Dam. The evolution from purely technical standard based approaches to integrated RIDM frameworks represents a paradigm shift in safety management, recognizing that catastrophic failures rarely result from technical factors alone, but from complex interactions between engineering decisions, organizational governance, economic pressures, and societal values.

9:45 am

Considerations for Multi-Year Construction of a Downstream Dam Raise in an Area Susceptible to Acid Rock Drainage

T. Walkenbach, C. Schuettpelz and S. Harkins; WSP USA Inc., Creve Coeur, MO

The Kensington Mine is located approximately 45 air miles northwest of Juneau, Alaska, in an area of coastal mountains. A portion of the tailings generated at the mine is placed subaqueously and stored in the Kensington Tailings Treatment Facility (TTF). To accommodate continued mine production, a TTF expansion will increase both the allowable water and tailings levels in the TTF. This expansion includes the Main Tailings Dam Stage 4a raise, which involves competent bedrock surface exposure downstream of the existing dam, seepage collection system and instrumentation installation, foundation treatment, and embankment construction. The extensive dam raise construction scope presents unique challenges, including limited construction season, spatial constraints, wet weather conditions, and remote site logistics. Presence of potentially acid-generating material necessitates a detailed excavation, stockpile management, acid rock drainage (ARD) material sampling and testing routine and decision-making plan. The ARD routine and decision-making approach, as well as coordination between multiple stakeholders, including Owner, Contractor, Engineer of Record, and CQA teams, will be described.

10:05 am

Applying Risk Methodologies to TSFs: Practical Challenges and Lessons Learned

A. Morales Torres, I. Escuder Bueno and F. Garcia Brook; Ingenieria de Presas SL (iPresas), Valencia, Valencia, Spain

The application of risk methodologies, such as semi-quantitative risk analysis (SQRA), to tailings storage facilities presents challenges that extend beyond the structured process itself. Drawing on more than 40 real-world applications across diverse geographies and operational contexts, this paper highlights practical issues, such as data uncertainty, cross-disciplinary alignment and adapting to different site conditions and organizational realities. It also considers the critical but often overlooked phase that follows the workshop: how the results are interpreted, prioritized and translated into meaningful actions within operational and regulatory constraints. Based on field experience, key lessons learned are shared to help practitioners enhance the effectiveness and long-term impact of SQRA in supporting dam safety and risk-informed decision-making.

10:25 am

Evaluating Seismic Stability Analysis Methods for Tailings Storage Facilities in Accordance with International Guidelines

D. Abarca, C. Barrueto, F. Leal and J. Campaña; Arcadis, Santiago, Región Metropolitana, Chile

In seismic regions, earthquake loads are a critical factor in assessing the stability of tailings storage facility (TSF) dams. This study compares two seismic stability analysis methods for TSF dams constructed with rockfill or tailing sands. Considering Limit Equilibrium Method (LEM) and Dynamic Stress-Strain analyses, we evaluate the results against each other and then compare them with acceptability criteria from international guidelines. The study identifies and discusses the challenges these methodological differences pose in the design and evaluation of these critical mining structures.

10:45 am

26-045

Overview of the Process on Risk Informed Decision Making in Mining Dams/ Tailings Storage Facilities - Position Statement from USSD and CDA

C. Sandhu and A. James; Professional Engineer (P.Eng.) pmP, Winnipeg, MB, Canada

The Risk Informed Decision Making (RIDM) Working Group, formed under a joint initiative by the USSD Tailings Dam Safety Committee and the CDA Mining Dam Safety Committee, is tasked with developing guidelines for applying RIDM in the design and management of mining and tailings dams in both the U.S. and Canada. At the 2024 CDA Conference in Niagara Falls, Ontario, a dedicated workshop brought together regulators, utilities, mine owners, operators, engineers, geoscientists, and social practitioners to share insights and diverse perspectives on RIDM. The session featured case studies from the CDA and USSD steering committees and mining organizations, offering practical examples of RIDM implementation. Key lessons learned and areas of divergence were discussed, emphasizing the importance of context-specific approaches. Based on workshop feedback, the group developed a refined RIDM process flow diagram tailored to tailings storage facilities (TSFs), aiming to support more transparent, defensible, and risk-aware decision-making.

11:05 am

Panel Discussion After Presentations (if time allows)

Wednesday, February 25
Morning

VALUATION: CASE STUDIES

150D-E

Chairs: ***Z. Smith****, Withum, Jersey City, NJ*
H. Cahill*, Cahill Mining Consulting*

9:00 am

Introductoins

9:05 am

Non-securities-related Mineral Reserves Reporting – Case Studies

B. Groff; Groff Engineering & Consulting LLC, Mt. Sterling, KY

Recent court cases have renewed an awareness of how estimates and statements of mineral resources and reserves are being used outside the reporting and disclosure systems of securities and exchange commissions. Reporting resources and reserves in the US for public and private purposes should follow the SME Guide for Reporting Exploration Results, Mineral Resources, and Mineral Reserves. The recent cases illustrate how some reporting falls short of those standards and the financial implications of each. The scope of this paper mentions but excludes a discussion of mineral valuation, which is different than mineral evaluation and mineral reserves reporting.

9:25 am

Comparison of Trends in Gold Property Transaction Values, Mineral Resource and Mineral Reserve Reporting, and Gold Price (2012-2025)

G. Malensek[1], W. Roscoe[2], P. Chamois[2], P. Landry[2] and J. Cox[2]; [1]SLR International Corp., Lakewood, CO and [2]SLR Consulting (Canada) Ltd., Toronto, ON, Canada

SLR has tracked transactions on gold properties worldwide from 2012 to 2025. For comparative purposes, the transaction values are expressed in US dollars per ounce gold ($/oz Au). Our analyses show that $/oz values are significantly higher for producing properties than for non-producing properties, as expected. However, last year's presentation showed that $/oz values unexpectedly decreased from 2021 to 2024 as gold prices increased dramatically. This presentation investigates whether this downward trend in $/oz Au values continues in 2025 as gold prices climb even higher. In addition, SLR will also investigate similar divergences between current gold prices and corporate Mineral Resource and Mineral Reserve prices in their annual reporting.

9:45 am

Creating Value and Managing Risk with Staged Development at a Long-Life Copper Project

M. Samis; SCM Decisions, Toronto, ON, Canada

Staged project development is often touted by the mining industry as a means of reducing upfront capital costs and managing risk. Qualitative arguments are used to justify staged development over a front-loaded capital design rather than prepare a quantitative analysis, as a conventional cash flow model often disadvantages staging due to its delayed cash flows and higher initial operating costs. However, this disadvantage is corrected when a staged design's potentially lower technical risk and execution risks are explicitly recognized with a dynamic cash flow model. This presentation uses dynamic cash flow modelling to demonstrate that staged development of a long-life copper project can be more valuable and less risky than a front-loaded capital design due to the learning benefits of staging and the higher likelihood of financing a project with lower initial capital requirements.

10:05 am

Artisanal Small-Scale Mining as a Risk Modifying Factor – The Case of MMG Las Bambas, Peru

A. Recalde; Canadian Institute of Mining Metallurgy and Petroleum, Oakville, ON, Canada

International codes for mineral resources estimation emphasize the importance of a comprehensive approach to mineral project evaluation. CRIRSCO's criteria include Modifying Factors (MF), among which Environmental, Safety, and Governance (ESG) aspects are now considered integral to project viability. Artisanal small-scale mining (ASM) in emerging countries is recognized as a project risk. This paper discusses the consideration of ASM as a Modifying Factor for risk assessment. In Peru, ASM activities have a significant presence, and regulatory oversight by the national government has been limited. ASM operations often obtain social legitimacy from local communities, as rural landowners may prefer permitting ASM activities over those of formal large mining companies (LMCs). MMG, is a LMC operating in Peru. It operates Las Bambas mine in the Apurimac Region. Project Pamputa (PP) is a large ASM operation operating adjacent to Las Bambas. PP has recently expanded to operate in mining concessions originally granted to MMG. This is possible due to social acceptance despite the lack of legal entitlement to extract ore from these concessions. This paper describes PP as a Modifying Factor.

10:25 am

Enhancing Cost Estimation and Analysis with Machine Learning (AI)

G. Sobering; Member, Highlands Ranch, CO

As the mining industry faces increasing pressure to deliver accurate, timely, and transparent project evaluations, the integration of artificial intelligence into cost estimation and analysis has become essential. Costmine Intelligence has delivered trusted mining cost data to the industry for decades, and has now introduced its AI based cost modelling engine, Woody. Attendees will gain an understanding of how AI-driven tools are reshaping the rapid extraction and analysis of cost data in the mining sector, enabling reproducible, and auditable insights across global mining properties. Case studies will demonstrate how these tools reduce manual effort, improves data fidelity, and supports strategic decision-making.

10:45 am

A Technical Investigation into Unprecedented Cost Overruns of Mining Projects

E. QUANSAH and A. Anani; University of Arizona, Tucson, AZ

Feasibility studies in mining often paint rosy economics that execution fails to match, draining capital. Global reviews show only one-fifth of new mines land within estimated capex, while two-fifths treble original budgets. This research will dissect the technical anatomy of those overruns across 20+ mining projects commissioned between 2000-2022. Methods such as variance mapping, cost performance Index, machine learning, and estimate at completion would serve as analytical tools. Multivariate regression will then test how technical complexity, logistics bottlenecks, vendor concentration, regulatory churn, and execution strategy statistically drive mine cost blowouts. Expected outputs are probability-weighted capex multipliers, early-warning indicators, and an open diagnostic framework that can be embedded in front-end cash-flow models. By clarifying how modern cost inflation propagates through design choices, the project aims to temper optimism bias and restore capital discipline as the energy-transition metals boom accelerates.

Wednesday, February 25
Afternoon

COAL & ENERGY: URANIUM, LAND RECLAMATION, & ALTERNATIVE ENERGY

Sponsored by BARR

151 A-C

Chairs: ***W. Goranson****, Hot Metal Consulting LLC, Corpus Christi, TX*
M. McBrayer*, Navajo Transitional Energy*

2:00 pm

Introductions

2:05 pm

26-018

Critical Minerals Potential of Uranium Deposits in New Mexico

V. McLemore, R. Boakye and Z. Kazemi Motlagh; NMBGMR/NM Tech, Socorro, NM

The most significant uranium deposits in New Mexico are sandstone-hosted deposits in the Morrison Formation (Westwater Canyon Member), where >169,500 short tons of U_3O_8 were produced from 1950 to 2002. In addition, >9076 pounds of vanadium (a critical mineral) and some molybdenum were produced from these deposits. These and other uranium deposits (limestone-hosted, uranium veins) in New Mexico also contain critical minerals. Critical minerals are mineral resources that are essential to our economy and whose supply may be disrupted; many critical minerals are 100% imported into the U.S. Some sandstone-hosted, limestone-hosted, and uranium vein deposits are elevated in heavy rare earth elements. One sandstone-hosted sample contained 0.3 ppm Re (critical mineral), 659 ppm Se and 408 ppm Mo. The arsenide five-element vein deposits in the Black Hawk district are mineralogically and texturally complex, low- to moderate-temperature, hydrothermal, structurally-controlled Ag-Co-Ni-Bi-As bearing carbonate vein systems with local minor elements. Mineralized samples from Black Hawk contain up to 9970 ppm Ag, 8540 ppm As, 5690 ppm Co, 72,400 ppm Ni, 57 ppm Bi, 165 ppm Sb, and 32,600 ppm U.

2:25 pm

Cleaning Up the Past, Fueling the Future: HPSA for AUM Remediation and U/V Recycling

J. Lee; DISA Technologies, Inc., Casper, WY

DISA Technologies is deploying High-Pressure Slurry Ablation (HPSA) to remediate abandoned uranium mines by selectively liberating and recycling uranium and vanadium from contaminated soils and waste rock. This modular, mobile technology enables on-site processing, significantly reducing transportation and disposal costs. In collaboration with public and private stakeholders, DISA identifies, characterizes, and processes legacy waste to concentrate uranium and vanadium into a fine fraction for off-site recovery and recycling, transforming waste into valuable, energy-critical resources. Validated by the U.S. EPA, HPSA delivers a field-deployable, cost-effective solution for site cleanup and strategic material supply chain development.

2:45 pm

Potential Energy: Challenges and Considerations of Reopening a Legacy Uranium Site

L. Billin[1] and D. Kolkman[2]; [1]Linkan Engineering, Elko, NV and [2]Energy Fuels Inc, Lakewood, CO

Legacy sites act as a coiled spring, containing substantial resources biding their time to be unleashed as market conditions improve. As favorable conditions for uranium production increase, the focus of producers shifts to the practicalities of site revival. Herein Energy Fuels, the premier uranium producer in the United States, and Linkan, a leader in mine water treatment, present the challenges associated with reopening legacy sites. We leverage the real-world experience of a recently reopened uranium mine to provide practical solutions for navigating updated permitting and environmental requirements, infrastructure repairs and improvements, and leveraging existing systems available onsite.

3:05 pm

The South Texas Uranium Province

K. Deatrick; enCore Energy, Corpus Christi, TX

The South Texas Uranium Province comprises the third largest sandstone-hosted uranium resources in the U.S. The principal uranium-bearing formations include the Eocene Claiborne and Jackson Groups, Oligocene Catahoula Formation, Miocene Oakville Sandstone, and the Pliocene Goliad and Willis Formations. Uranium mineralization hosted within these formations are found in a wide range of depositional systems including mixed marine coastal systems of the Claiborne and Jackson Groups to predominantly terrigenous fluvial clastics of the Catahoula, Oakville and Goliad Formations. Although poorly documented due to limited studies, uranium enrichment of the Catahoula Formation may be better understood through local phreato-magmatic volcanism, contemporaneous with regional windblown volcanic activity. Roll-front development is initiated through leaching and migration of uranium from the enriched Catahoula Formation into downdip reservoirs. Regional faults, often controlled by salt tectonics, circulate reduced fluids from deep hydrocarbon systems. These fluids interact with uranium-enriched and oxidized groundwaters, leading to the formation of stacked roll-fronts across the South Texas region.

3:25 pm

Optimizing Uranium Recovery: A Smarter Approach to In-Situ Mining

K. Johnson; Barr Engineering Co, Minneapolis, MN

In-situ recovery (ISR) of uranium is a commonly employed method for uranium extraction, valued for its low environmental impacts and cost-effectiveness. Yet, maximizing uranium recovery remains a challenge due to the complex interplay of hydrogeological, chemical reactions, and economic factors. Our research illustrates how oxidant in the lixiviant is consumed by reactions with pyrite and organic carbon within the aquifer, slowing down the rate of uraninite dissolution. In addition, the rate of increasing uranium concentration in the recovery wells slow as uraninite is removed. Advanced PHT-USG modeling that couples geochemical reaction with transport provides insight into the effects of changing permeability and amounts of pyrite and organic carbon on uranium recovery. This presentation introduces a new modeling framework that combines hydrogeochemical simulations with evolutionary optimization algorithms. The result is a powerful toolset that helps design more efficient wellfields and optimize key performance metrics like uranium yield, chemical usage, and energy costs. This integrated approach offers a smarter, more sustainable path forward for ISR operations.

3:45 pm

Reclamation of Multiple Abandoned Mine Land Features Export Borough, Westmoreland County, PA

R. Kudlawiec; Tetra Tech Inc, Murrysville, PA

Tetra Tech, Inc. was selected by the Export Historical Society (EHS) to provide professional and technical services to design, identify and obtain all necessary permits to facilitate the reclamation of a mine opening, a vertical opening, and a subsided area over property owned by Export Borough, Westmoreland County, Pennsylvania. This work was considered as Phase 1 of an overall mine remediation project. Phase 2 of the project involves closing of mine openings to eliminate the associated hazards to the public and the development of a connecting spur to the Export Branch of the Westmoreland Heritage Trail. The remediation of the abandoned mine openings will minimize the risk of injury for people, improve the environment, and facilitate economic development and expansion of tourist attractions in Export. This paper discusses the project from inception, through design, construction to completion.

4:05 pm

Project Background and Development for the Little Conemaugh Mine Drainage Treatment Plant Project, Portage Township, Cambria County, Pennsylvania

E. Cavazza; Tetra Tech, Inc., Pittsburgh, PA

The Little Conemaugh River Watershed is significantly impaired by drainage from abandoned coal mining operations. The Pennsylvania Department of Environmental Protection (PA DEP) in partnership with several other stakeholders began efforts in 2016 to restore the Little Conemaugh River from its headwaters to its confluence with the Stonycreek River in downtown Johnstown – a distance of approximately 15 stream miles. The effort is focused on the three most upstream major AMD discharges including the Hughes Borehole, the Sonman Borehole Discharges, and the Miller Shaft Discharge. The Foundation for Pennsylvania Watersheds (FPW) has been a major partner in the restoration effort. PA DEP awarded FPW an Infrastructure Investment and Jobs Act (IIJA) funded AMD Grant in September 2023 to complete the design and permitting of the mine drainage treatment plant. FPW awarded a contract to Tetra Tech through a competitive RFP process in December 2024. Background information including details about the abandoned mines and discharges, the current plan drawings, and the project status and schedule will be presented.

Wednesday, February 25 Afternoon

ENVIRONMENTAL: INNOVATIVE ENGINEERING FOR SUSTAINABLE MINE CONTAINMENT AND RESTORATION

255D

Chairs: ***M. Isola****, WSP, Tampa, FL*
N. Shah*, WSP USA Inc, Tampa, FL*

2:00 pm

Introductions

2:05 pm

Long-Term Performance of Food Waste Compost in Suppressing Acid Mine Drainage Generation in Fine Coal Refuse

W. Liu and X. Yang; University of Utah, Salt Lake City, UT

This study evaluated the long-term efficacy of compost and compost water extract (CWE) in suppressing pyrite oxidation through 70-week kinetic column leaching (KCL) tests using fine coal refuse (CR) samples with relatively low and high pyrite levels (9.3% versus 12.7% in Fe) The KCL tests involved weekly-watering the CR and compost-amended CR by deionized water, and the calcite-amended CR by CWE. It was found that, except for the AMD generation after week 47 in the compost-amended high-pyritic CR, the compost or CWE treatments effectively suppressed AMD generation and potential toxic element release throughout the study. Distinct Fe-S-Al-Si-O-enriched coating layers with aggregate-like morphologies were observed on pyrite surfaces in the compost or CWE treated columns, although the coverage and thickness are heterogenous. The performance of compost amendment method could be further improved by increasing compost dose or adding extra alkalis. Overall, compost could mitigate pyrite oxidation and AMD generation in the low-pyritic coal refuse by inducing the formation of passivation layer via organo-mineral interactions and serving as a neutralization capacity, respectively.

2:25 pm

26-014

Concrete Production for Underground Mining Using Mine Tailings

L. Mendieta Britto, O. Cabello and M. Guzman; Pontificia Universidad Catolica del Peru, Lima, Peru

Mineral flotation processes generate large volumes of tailings, which must be disposed of efficiently and safely. In addition to dry stack disposal, the possibility of reusing these tailings as aggregates in shotcrete is an interesting alternative. Tailings samples from a mining operation in southern Peru were characterized by granulometric analysis, X-ray diffraction and Scanning Electron Microscopy. Concrete samples were obtained with different tailings formulations. The samples were subsequently subjected to geomechanical testing. The results showed that replacing 20% to 30% of the tailings with aggregates in shotcrete production achieved compressive strengths exceeding 30 MPa after 28 days of curing, with an energy absorption capacity of 500 joules. Results show that this shotcrete can be used in the support stage of the mining cycle in underground mining. Keywords: circular economy, shotcrete, tailing, underground mining.

2:45 pm

Advancing Sustainable Mining: Evaluating Calcium-Activated Pozzolanic Binders for Low-Carbon Cemented Paste Backfill

S. Li[1] and L. McFarlane[2]; [1]University of Utah, Salt Lake City, UT and [2]Graymont, Sandy, UT

Cemented paste backfill (CPB) is a critical practice in modern underground mining, enabling the safe storage of mine tailings while providing essential ground stability. However, traditional CPB relies heavily on Portland cement as the primary binder, a material known for its high CO_2 emissions, accounting for up to 70% of the greenhouse gas footprint of the backfill process. To reduce the environmental impact and promote sustainable mining practices, this study investigates the use of calcium-activated pozzolanic binders as innovative, environmentally friendly, low-carbon substitutes in CPB mixtures. Representative copper and gold tailings sourced from various North American mine sites are tested using experimental approaches to evaluate their geotechnical and rheological compatibility with these alternative binders. While ensuring that the mixtures meet underground pressure control requirements, particular attention is given to their potential for environmental improvement. A systematic evaluation is performed to provide new insights and evidence on the feasibility of adopting the low-carbon binder for improving the sustainability of backfilling operations in the mining industry.

3:05 pm

The Use of a Bituminous Geomembrane to Reduce Cost and Risk for Mine Waste Applications

P. Kendall; IKO Coletanche USA, Marietta, GA

Geosynthetic liners play an important environmental role in containing fluids at mine sites. This role can include wastewater, tailings, process water, and solid waste. Reinforced bituminous geomembranes (BGMs) are thicker and heavier alternatives to more commonly used geomembranes. A BGM can reduce risk and cost compared to alternatives when the totality of the containment structure is considered. Case histories from USA, Canada, and Australia highlight how the unique mechanical properties of BGM added value on a range of mining containment applications.

3:25 pm

Geosynthetics Installations – Tips to Keep Your Asset from Becoming a Liability

G. Toepfer; CQA Solutions, Ltd, Toledo, OH

Geosynthetics when properly installed are an asset to mine owners because they protect the owner from liability and prevent the loss of other assets such as pregnant solution. To this end, owners allocate significant monetary resources towards project management, design, materials, contractors, installers, and construction quality assurance (CQA) to achieve the goal of a quality installation. Unfortunately, even spending top dollar on every vendor and material does not guarantee proper installation. This paper will discuss the findings from over ten years of site audits performed for site owners to evaluate the quality of geosynthetics installations on their sites. These site audits reveal concerning trends in the quality of geosynthetics installations which owners need to be aware of. Throughout this discussion, we will identify the most common issues pertaining to geosynthetics installations and provide recommendations on how to mitigate them before they turn your geosynthetic asset into a liability. The discussion will include key photographs and graphics.

Wednesday, February 25 Afternoon

ENVIRONMENTAL: POST-CLOSURE: UNCERTAIN, UNSETTLED, AND UNDERESTIMATED

255A

Chair: ***P. Werner****, US Department of Agriculture, Bozeman, MT*

2:00 pm

Introductions

2:05 pm

Murky Waters: An Analysis of Water Rights and Use in Nevada Mine Closures

M. Tanager; UNR, Reno, NV

Water management is a necessary component of many mining operations of various scales and types. The Nevada State Engineer regulates the quantities of water that mines may use, move, and hold for mitigation, and their use during operations is made more "scrutable" through ties to active extraction. However, many mines also hold quantities of water past their operational lifespans; these may be required to offset mining effects on local hydrology or as part of a complete mine package to be purchased. What changes occur to water rights and water use during mine closure, and what patterns of change exist between types of mine closure (short-term, long-term, and perpetual)? And how does the retention, transfer, or repurposing of water rights complicate assumptions about reclamation and final closure?

2:25 pm

Beyond Closure: Realities of Long-term Stewardship of Mine Sites

B. Nobis; Rio Tinto, South Jordan, UT

Mine closure is often perceived as a definitive endpoint—an administrative and operational conclusion to a site's lifecycle. However, in practice, closure is a continuum encompassing planning, execution, post-closure monitoring, and, in many cases, long-term or perpetual management. This paper challenges the conventional notion of closure as a finite process and highlights the persistent obligations that extend well beyond operational shutdown. Drawing on examples from legacy sites across North America, it explores the environmental uncertainties that emerge post-closure, the challenges of reconstructing site knowledge from outdated or incomplete records, and the evolving expectations for environmental stewardship. The discussion includes strategies for reducing long-term monitoring and maintenance (M&M), optimizing resource allocation, and identifying innovative pathways for site repurposing to offset ongoing costs. The paper also presents a case study of how Rio Tinto's growth-oriented project development framework has been successfully adapted to support legacy site management, offering a structured approach to navigating the complexities of post-closure responsibilities.

2:45 pm

Evaluating Post-Closure Care and Maintenance at Uranium Mill Tailings Facilities in the Western U.S.

T. Braun; SRK Consulting (U.S.), Inc., Denver, CO

Title II of the Uranium Mill Tailings Radiation Control Act of 1978 addressed siting, design, operations, decommissioning and long-term surveillance and control of tailings produced at conventional uranium milling operations licensed in 1978 or later. Appendix A to 10 CFR Part 40 defines technical, financial and long-term site surveillance criteria. Given the radiological hazard associated with uranium mill tailings, the criteria include reasonable assurance of effective engineering control for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. The U.S. Nuclear Regulatory Commission (NRC) has federal licensing authority for uranium tailings operations and closure. The NRC granted licensing authority to five Agreement States (Colorado, Texas, Utah, Washington and Wyoming). There are 20 Title II facilities in decommissioing, including 15 under the authority of Agreement States. Six additional Title II facilities are fully decommissioned and transfered to the U.S. Department of Energy for long-term monitoring. This presentation surveys post-closure care and maintenance activities at the Title II sites approaching or under long-term surveillance.

3:05 pm

Long-Term Liabilities at Hardrock Mine Sites – Legals Risks and Management Strategies

T. Bloomfield; Kaplan Kirsch LLP, Denver, CO

The perpetual generation of acid mine drainage (AMD) can impose massive environmental liability on owners and operators of hardrock mines. This liability can attach even decades after the cessation of mining, the completion of traditional reclamation and the sale of the property. These risks arise under a range of federal and state laws: statutes like Superfund and the Resource Conservation and Recovery Act, mining regulations, traditional common law theories, and claims for natural resource damages. This presentation will provide an overview these potential legal exposures, compare various state and federal programs, and present case studies from a range of former mine sites. This program will also explore lessons learned and identify best practices and tools for mitigating and managing these risks and costs.

Wednesday, February 25 Afternoon

HEALTH & SAFETY: MAKING HEALTH TECHNOLOGY WORK FOR YOU: TOOLS, TRENDS, AND LESSONS FROM THE FIELD

Sponsored by RioTinto

250A

Chairs: ***J. Sattarvand****, University of Nevada Reno, Reno, NV*
T. Beck*, CDC NIOSH, Pittsburgh, PA*

2:00 pm

Introductions

2:05 pm

Integrated Fatigue Management in Personnel Transportation: A Success Case from Newmont Yanacocha for Operational Safety and Efficiency

M. Portal Valdivia[1], F. Huaman[2] and J. Partor Cardenas[2]; [1]Society for Mining, Metallurgy & Exploration, Cajamarca, Cajamarca, Peru and [2]Newmont, Cajamarca, Cajamarca, Peru

Personnel transportation is a critical activity in mining, vital for operational continuity and safety. Driver fatigue management is paramount, given their responsibility for human lives. This study details Newmont Yanacocha's fatigue management strategy, initially involving 50 drivers and 21 units. The methodology integrates technological controls such as smartbands for sleep monitoring and systems for real-time detection of drowsiness, distraction, and GPS tracking. This is complemented by operational controls including route rotation, differentiated schedules, mandatory post-lunch rest, and hotel accommodation for critical routes. The activation of relief drivers when rest requirements are not met and the provision of a support pool reinforce the efficient flow of personnel transfer. This model was scaled across a significant portion of the operation (190 drivers, 100 units). The results demonstrate an increase in effective rest hours, achieving zero incidents attributable to fatigue or drowsiness, thus confirming the effectiveness of robust preventive management.

2:25 pm

26-004

A Multi-Factor Approach for Enhancing Real-Time Fatigue Monitoring in Mining Environments

K. Boakye[1], B. Afum[1] and K. Boakye[2]; [1]University of Mines and Technology-Tarkwa, Kumasi, Kumsai, Ghana and [2]Colorado State University, Fort Collins, CO

This research introduces the development and simulation of a Multi-Factor Fatigue Detection and Alert System (MFDAS) using MATLAB Simulink. The study contributes to enhancing the accuracy of fatigue detection in mining operations using a fuzzy logic-based system. MFDAS incorporates eye blink/closure, yawning, distraction, pre-shift scores, and Electroencephalogram levels. It accurately classifies operator fatigue into low, moderate, and high by processing these physiological and behavioral inputs and subsequently furnishes recommendations for timely intervention. The implementation of the fuzzy logic-based fatigue detection system exhibits high reliability for monitoring, achieving 85.19% accuracy across 27 test scenarios with a low standard deviation of 0.3553.

2:45 pm

The Impact of Extremely Hot Temperature Mining Environments on Human Health and Safety: Challenges, Adaptation Strategies, and Technological Solutions

E. Gyabaah, S. Frimpong and M. Raza; Missouri University of Science and Technology, Rolla, MO

The mining industry is increasingly facing the challenge of operating in high-temperature environments due to deeper excavations, hotter climates, and more intensive surface operations which elevate the risk of occupational injuries and illnesses. Evidence shows that injury claims are lowest around 25 °C maximum temperature and increase markedly during extremely hot days, particularly those in the 99th temperature percentile. This review evaluates the complex interplay between environmental factors, like humidity, altitude, and geothermal heat, the resulting health and safety hazards and associated occupational hazards and highlights proven engineering solutions while examining current adaptation strategies through the lens of the occupational hierarchy of controls. While administrative and personal protective measures remain essential, engineering controls emerge as the most effective defense against heat-induced hazards. The study provides a solid justification for intelligent automation and robotics for replacing humans in extremely high-temperature environments, with high human risks, which represents a paradigm shift towards safer, efficient, and more resilient mining systems.

3:05 pm

Quantifying the ROI of a Fatigue Risk Management Program Using the SmartCap Wearable EEG-Based System: An Open-Pit Mine Case Study

E. Tetzlaff; Wenco International Mining Systems, Batawa, ON, Canada

Fatigue is a well-known hazard in mining, contributing to safety incidents, health risks, and reduced productivity. Yet, many safety leaders struggle to quantify the return on investment (ROI) of fatigue risk management programs. This field-based case study, conducted at a large surface mining operation, assessed the ROI of an integrated approach combining a fleet management system (WencoMine®) and a wearable EEG-based alertness monitoring solution (SmartCap®). The program included real-time monitoring, escalation protocols, tiered training, and policy changes. By analyzing SmartCap® and WencoMine® data and comparing it to the prior year, the study showed reduced fatigue-related incidents, improved alertness, increased self-management, and fewer dispatch interventions. Operational benefits included fewer roadway incidents, lower fuel consumption, more productive hours, and shorter spotting time. A cost-benefit analysis revealed strong ROI from reduced downtime, injuries, and improved shift efficiency. These results demonstrate the health, safety, and measurable business value of embedding advanced fatigue technologies in mining.

3:25 pm

Direct-on-Filter Raman Spectroscopy for Quantifying Respirable Crystalline Silica in Coal Mine Dust: Challenges and Considerations

B. Osho[1], L. Raymond[1], M. Elahifard[2], Y. Jin[1], B. Abbasi[1], J. Chow[2], J. Watson[2] and X. Wang[2]; [1]University of Nevada, Reno, Reno, NV and [2]Desert Research Institute, Reno, NV

Direct-on-Filter (DoF) analysis by Raman spectroscopy has been proposed as a more sensitive alternative to Fourier Transform Infrared Spectroscopy (FTIR) for quantifying respirable crystalline silica (RCS) in mine dust samples. When sensitivity is expressed in terms of RCS mass per area, this study demonstrates that portable Raman and FTIR spectrometers exhibit comparable limits of detection (LOD). However, high-sensitivity Raman microscopes can achieve LODs that are more than an order of magnitude lower than those of FTIR. Four key challenges in applying Raman for RCS analysis were investigated: particle deposit uniformity, chemical composition heterogeneity, fluorescence interferences, and sample heating caused by the Raman excitation laser. Results show that concentrating samples on smaller filter areas improves deposit homogeneity, while ashing reduces chemical heterogeneity and fluorescence from organic materials. While a Raman with a 1062 nm laser caused coal samples to burn, a 532 nm laser at moderate power was able to remove organics and enhance the RCS signal without damaging the sample.

3:45 pm

Characterization of Respirable Mine Dust from Coal and Limestone Strata

S. Torabi and S. Liu; The Pennsylvania State University - University Park Campus, University Park, PA

Respirable crystalline silica (RCS) found in coal mine dust is a well-known cause of serious lung diseases like silicosis. However, less attention has been given to the role of amorphous silica and other silicate minerals that may also pose health risks. In this study, samples from rock strata on top and bottom of coal seams, as well as from the roof and pillar of a limestone mine in Pennsylvania were collected. To simulate real mining conditions, respirable dust was created using cryogenic ball milling. The samples were then analyzed using X-ray diffraction (XRD), combined with JADE software and an internal standard method, to identify and measure the minerals present. The findings show that α-quartz is the only type of crystalline silica in the coal samples, along with notable amounts of muscovite and kaolinite. Limestone samples, on the other hand, were mostly made up of calcite and contained very little quartz. Overall, this research points to the importance of assessing both crystalline and amorphous materials to better understand and manage the health risks linked to respirable mine dust.

4:05 pm

Ergonomics in Action: Practical Improvements for Core Logging Facilities

R. Ganske[1], S. Conner[2], J. Williams[1] and J. Ellis Evans[1]; [1]Rio Tinto, Salt Lake City, UT and [2]Rio Tinto, South Jordan, UT

Manual core handling is a major part of logging and assaying, but it's also one of the most injury prone. Poor ergonomics can lead to both short- and long-term health issues, making improvements essential. Enhancing ergonomics not only boosts worker safety but can also improve efficiency and data quality. At Kennecott's core facility, targeted changes have reduced repetitive strain injuries and increased throughput. This case study shows how small and medium changes can implement scalable, cost-effective ergonomic solutions. The results offer a practical model for modernizing core facilities, improving operational performance, and prioritizing worker well-being through measurable, impactful changes.

Wednesday, February 25 Afternoon

INDUSTRIAL MINERALS & AGGREGATES: HEALTH & SAFETY IN INDUSTRIAL MINERALS (JOINT SESSION WITH HEALTH & SAFETY DIVISION)

250C

Chairs: ***R. Mitra****, South Dakota Mines, Rapid City, SD*
A. Gregor

2:00 pm

Introductions

2:05 pm

Detecting Void-Prone Zones in a Surface Mine with Historical Underground Workings Using Measure While Drilling (MWD) Data and Machine Learning

J. Addy and E. Westman; Virginia Tech, Blacksburg, VA

Void-prone zones from historical underground workings pose significant geotechnical and safety risks in surface mining, including collapse, equipment instability, and personnel exposure. Traditional detection methods such as probe drilling, seismic surveys, and visual inspection are restricted by low resolution, limited spatial coverage, and lack of real-time applicability. This study presents a machine learning framework for detecting void-prone zones using Measurement While Drilling (MWD) sensor data collected from production drill patterns in a surface mine with historical underground workings. The methodology preprocesses MWD parameters (rate of penetration, torque, RPM, weight on bit, and air pressure) and applies exploratory analysis to reveal anomalous responses. Unsupervised clustering (K-Means) identifies drilling signatures linked to subsurface anomalies, while supervised models (Random Forest) are trained where labeled void data exist. The goal is to develop a predictive model that generates spatial indicators of geotechnical risk, enhancing safety planning and improving decision-making as mining advances into old underground workings.

2:25 pm

Characterization and Toxicity Analysis of Respirable Mine Dust and Crystalline Silica Dust in Non-Metal Mines

S. Siahidouzazar[1], T. Sharmba[2], M. Rezaee[2] and P. Roghanchi[1]; [1]University of Kentucky, Lexington, KY and [2]Penn State University, State College, PA

Respirable mine dust poses health hazards in non-metal mines, leading to diseases such as silicosis and other respiratory disorders. This research will assess the characterization and toxicity of respirable dust obtained from four underground mines. Dust samples were collected with Escort Elf pumps and Dorr-Oliver cyclones. Collected samples were subjected to Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), X-ray Diffraction (XRD), and bioavailability analyses. The results showed that larger particles contributed more to the total mass, while submicron particles accounted for 60% of the particle numbers. Findings provide insights into the composition and health hazards associated with respirable dust in non-metal mines.

2:45 pm

An Autonomous Drone Inspection System for Underground Room and Pillar Mines

K. Joao[1], H. Khaniani[3], V. Androulakis[3], M. Hassanalian[3], S. Shao[2] and P. Roghanchi[1]; [1]University of Kentucky, Lexington, KY; [2]Colorado Shool of Mines, Golden, CO and [3]New Mexico Tech, Socorro, NM

Conventional safety inspections often require personnel to enter hazardous environments, underscoring the need for a safer, remote alternative. This research presents the development and validation of an autonomous Unmanned Aerial Vehicle (UAV) system for remote inspection in room-and-pillar underground mines. The proposed system integrates the PX4 flight stack with MAVSDK for offboard control and employs Visual-Inertial Odometry (VIO) for real-time localization in GPS-denied environments. A series of test flights were conducted in both an indoor drone cage and an underground mine to evaluate the UAV's performance when executing inspection tasks, including stable hovering, incremental movement, and controlled flight around vertical obstructions. Results demonstrated consistent maneuverability in confined spaces, with significant improvements in VIO stability under enhanced lighting conditions. This research offers a scalable and repeatable solution for autonomous UAV-based mine inspections, reducing human exposure to risk and enhancing the reliability of underground safety assessments.

3:05 pm

Evaluating Direct-on-Filter FTIR Analysis for Respirable Silica Monitoring at Aggregates Operations

M. Uluer and E. Sarver; Virginia Polytechnic Institute and State University, Blacksburg, VA

Direct-on-filter (DOF) analysis of respirable dust samples by portable FTIR can offer rapid, on-site measurements of quartz, which is commonly used as a surrogate for respirable crystalline silica (RCS). DOF FTIR has been suggested for a range of applications, from enabling end-of-shift RCS monitoring results to supporting various engineering studies — and it has been demonstrated in some coal mines. However, use of DOF FTIR in aggregates operations could be challenging if (a) quartz is not the only form of RCS present and/or (b) other minerals interfere with the quartz measurement. In this field study across multiple aggregate sites, we evaluated the correlation between FTIR-measured quartz and RCS mass measured by a standard reference method (i.e., X-ray diffraction by NIOSH Method 7500). At each site, sampling was conducted in various locations, and sites were grouped by dominant geology to assess the feasibility of site-specific or geology-specific calibration factors. Results offer early insights into where and how aggregate operations might use a simple DOF FTIR method.

3:25 pm

Parameterizing Drone Flight in Underground Mine Environments: Is There an Optimal Flight Path?

C. Spurlock, G. Rath and P. Roghanchi; University of Kentucky, Lexington, KY

This project explores the effects of confined spaces and high airflow dynamics on drone performance and flight parameters. It investigates the aerodynamic forces acting on drones when flying near ceilings and walls under such conditions, to optimize drone flight paths in underground settings. A biaxial drone force-effect measurement device was developed. The instrument is designed to record key metrics, including position, acceleration, vibration, and force. The underground mine is simulated using a 4 ft by 4 ft wind tunnel, where ceiling and wall surface types can be altered for turbulence replication. The study shows that proximity to the ceiling and wall is crucial for their stability and efficiency. Flight paths in the center of the tunnel are optimal for speed and efficiency, as the drone is furthest from obstacles and the air is most predictable. The operational envelope, while flying closer to the ceiling, is most efficient when traveling against the wind, as it minimizes power loss from high wind resistance while still being in somewhat stable air. In the future, these flight parameters will be validated using a quadcopter drone in an active mine.

3:45 pm

Highwall Remediation: Combining Technology and Field Experience for Safer Operations — A Case Study

J. Diaz Martinez and P. Rangitsch; Martin Marietta, West Chester, OH

Highwall mining is widely utilized in both surface and underground operations due to its cost-effectiveness and versatility. However, maintaining highwall stability remains a critical challenge. Instability poses serious safety risks, especially when mining continues beneath the highwall, with potential for sudden failure threatening both miners and equipment. This paper presents a case study examining a limestone quarry in the U.S. that experienced highwall instability near the primary crusher structure. To address the issue, LiDAR scanning, Rockfall Hazard Analysis, and the Colorado Rockfall Simulation Program (CRSP) were used. While these tools provided essential data, it was the integration of engineering judgment, field experience, and site-specific insights that led to effective and affordable stabilization measures. The remediation significantly improved slope stability, enhanced safety, and ensured production continuity. This case underscores the importance of integrating advanced technology with practical field knowledge to manage geotechnical risks in mining effectively. Keywords: Highwall Stability, Mine Safety, Surface Mining, and Practical field experience.

Wednesday, February 25 Afternoon

MINING & EXPLORATION: GEOSCIENCE: ADDRESSING INFORMATIONAL SILOS: STRATEGIES FOR SEAMLESS VALUE STREAM INTEGRATION PANEL

255B

Chair: ***M. Sorensen****, Rio Tinto, South Jordan, UT*

2:00 pm

Introductions

2:05 pm

Mining & Exploration: Geoscience: Addressing Informational Silos: Strategies for Seamless Value Stream Integration Panel

J. Baar; Lead Ore Control Geologist, Post Falls, ID

This panel will address the persistent challenge of informational silos in mining operations and their impact on efficiency and decision-making. Through real-world examples and expert perspectives, the session will explore how integrating geoscience data across departments can unlock value, enhance collaboration, and drive better business outcomes. Special attention will be given to the benefits of downstream partnerships and highlight the role of geoscience integration into the commercial aspects of a mine for achieving seamless value stream alignment. Panelists include Jennifer Baar, Ryan Hunter, Emily Rose, and Nicolas Yarrington.

Wednesday, February 25 Afternoon

MINING & EXPLORATION: GEOSCIENCE: GEOTECHNICAL INNOVATIONS II: UNDERGROUND

250F

Chairs: ***C. Goss****, Schnabel Engineering*
E. Rouleau*, Schnabel Engineering, Marquette, MI*

2:00 pm

Introductions

2:05 pm

Does Basalt Fiber Have a Place in Mining?

B. Gage; Kennecott Utah Copper, Saratoga Springs, UT

Basalt Fiber Reinforced Polymer rebar (BFRP) has been used in place carbon steel rebar in construction due to its higher tensile strength, lower density and resistance to corrosion and conductivity. The Kennecott Utah Copper Underground Geotechnical Team is investigating potential applications of BFRP products as a substitute for base ground support elements made from carbon steel, e.g. rock bolts, wire mesh and fibers for shotcrete. The susceptibility of carbon steel to corrosion in high sulfide, wet mining environments can rapidly deteriorate the strength of ground support elements putting at risk personnel and incurring substantial rehabilitation costs and production delays. Can corrosion resistant BFRP products effectively replace our typical underground support elements and meet the quasi-static and dynamic demands of rockmass behaviour?

2:25 pm

Instrumented Split Set to Measure Rock Movement

J. Johnson; University of Utah (retired), Salt Lake City, UT

A new instrumented Split Set rock bolt has been developed and successfully field tested at an underground mine. A Split Set places the measurement device near the bottom of a borehole, where it measures displacements caused by mining, tunneling, and other earthworks. These displacements can be used to validate computer models, determine stress changes, and for ground monitoring; all of which improves safety for the miner. It is ready for commercial development but needs a business plan and a company to carry it forward.

2:45 pm

Effect of Particle Size Distribution on the Strength of Cement Paste Backfill

B. Arnold and R. Pandey; Virginia Tech, Blacksburg, VA

The strength of cement paste backfill (CPB) is a critical parameter for safe underground mine operation. Fracture initiation pressure (FIP) was previously introduced as a novel measure to assess CPB tensile strength. However, the influence of particle size distribution (PSD) on CPB strength remains unclear. This study examines the effect of PSD on CPB strength, particularly the FIP. CPBs were made with ground silica covering a range of PSDs commonly associated with mine tailings, along with varying binder content and curing duration. Results aim to support the industrial adoption of hydraulic fracturing as a reliable tensile strength assessment method.

3:05 pm

Geosensing in Bedded Evaporite Deposits

A. Greenblatt; REI Drilling Inc., Salt lake City, UT

Geophysical data gaps in bedded evaporite deposits present risks to mining operations, including unexpected ground conditions and potential water inflows. To address these hazards, underground directional drilling integrated with geosensing technology provides critical real-time subsurface data that enhances geologic models and supports safer, more informed mine planning. The geosensing system combines drill rig and wellhead-mounted sensors with analytical software to produce high-resolution data throughout the drilling process. This enables accurate 3D modeling of subsurface features—ahead of mining—and significantly expands on the insights gained from conventional in-seam directional drilling. The system improves the characterization of evaporite deposits by identifying soft or weak zones, geologic discontinuities, and analyzing formation flow. This presentation describes the geosensing system and showcases data from long in-seam directionally drilled exploration boreholes at a Canadian mine. The case studies illustrate how this integrated approach enhances the value of directional drilling as both an exploration and risk mitigation tool in complex geologic environments.

3:25 pm

Evaluating Limestone Pillar Stability: From Empirical to Numerical Methods

G. Zhao, A. Pfaff, C. Goetz, R. Ray, J. Mulcahey, J. Fritch, B. Haugen, B. Slaker and K. Mohamed; RESPEC, Rapid City, SD

Underground limestone pillar stability is essential for mine safety. This study will compare three commonly applied approaches: the empirical S-Pillar equation, the boundary element-based LaModel, and the finite difference software FLAC3D. Each method offers unique strengths, ranging from preliminary evaluation to detailed stress and failure analyses. S-Pillar provides safety factor estimates based on UCS, pillar geometry, discontinuity characteristics, and tributary area loading. LaModel extends the assessment to pillar systems, also accounting for surface topography. FLAC3D is capable of more complex and high-resolution 3D geometry, including surface topography but also irregular pillar geometries, such as those generated from LiDAR scans. It can simulate brittle failure characteristics and provide more precise stress distributions and detailed failure analyses. Several representative scenarios are presented to highlight the capabilities and limitations of each method and how they might be integrated effectively across design scales and project phases. This integrated approach promotes a more complete understanding of limestone pillar behavior.

3:45 pm

Innovations – The Use of Natural Fibers in Shotcrete An Overview of Benefits, Challenges, and Applications

W. Geers; Solomon Colors, Valrico, FL

The integration of natural hydrophilic (water-absorbing) fibers into shotcrete has emerged as a promising innovation. This advancement improves the cost-effectiveness of the shotcrete application by reducing rebound and being more cohesive allowing for thicker lifts. They also provide plastic shrinkage crack mitigation and internal curing of the sprayed concrete enhancing long-term durability. Additionally, the use of natural fibers supports sustainable construction practices. This paper examines the characteristics of natural fibers, the mix design, incorporation of the fibers into the mix and performance characteristics of shotcrete. The paper provides a review of laboratory and field applications, demonstrating the benefits of incorporating natural fiber reinforcement in any shotcrete application!

Wednesday, February 25 Afternoon

MINING & EXPLORATION: INNOVATION & TECHNOLOGY: ELECTRIC VEHICLES (EV) ROADBLOCKS AND PATHS FORWARD

Sponsored by Newmont

255F

Chair: ***A. Crose****, Aptiv, Danville, IL*

2:00 pm

Introductions

2:05 pm

Worlds First Fully Battery Electric Underground Trolley System

R. Dittakavi and J. Bretzius; ABB, Salt Lake city, UT

As the mining industry faces mounting pressure to reduce its carbon footprint, while being productive with optimal TCO, Fleet electrification emerges as a transformative solution—one that not only curbs emissions but also enhances operational efficiency and resilience. This presentation walks the audience through the journey of worlds first battery electric underground trolley system implemented by Boliden in collaboration with ABB and Epiroc. Implementation started with 800mt of test track and now full 5km has been implemented.

2:25 pm

Revolutionising Heavy Haulage: Australia's First Retrofitted Battery-Electric Haul Truck

C. Franklin; None, Perth, WA, Australia

The mining industry faces a hard truth: diesel emissions must fall, and fast. But what if there's no time to wait for OEMs to deliver battery-electric trucks that are still years away? What if the solution is already here, hidden in the existing trucks that miners are using today? Clayton will talk about the engineering breakthroughs, challenges, and surprising lessons learned from the CAT777 project. He'll explain why mining operations need to rethink charging strategies, energy management, and even how haul roads are built. He'll also share exclusive data from EPCA's field testing, showing how battery-electric trucks can match, and sometimes beat, diesel trucks in real-world mining conditions. And why does retrofitting offer a faster, more practical path to decarbonising mining fleets? Key takeaway: - Understand how retrofitting diesel trucks to battery-electric can cut emissions now. - Learn real-world performance results from Australia's first 100t electric haul truck retrofit. - Explore how charging cycles and energy management impact mine operations. - See how retrofits can offer a faster, lower-risk path than waiting for new OEM trucks.

2:45 pm

Retrofit or Replace? Making the Case for EV Retrofit of Existing Light Vehicle Fleets

S. Hill; Industry Partner, Provo, UT

Hypercraft electrified a Ford F-250 fleet vehicle for Thiess, a global mining services provider, in support of their ESG goals. The electric conversion was engineered for the demanding conditions of surface mining, where durability, power, and uptime are essential. Hypercraft replaced the internal combustion system with a high-performance electric powertrain, scalable lithium-ion battery pack, and intelligent energy management, significantly reducing emissions and noise. The retrofit preserved full vehicle utility while eliminating tailpipe emissions, aligning with Thiess's decarbonization strategy. By utilizing Hypercraft's modular EV technology, Thiess now has a scalable model for fleet-wide electrification. The pilot vehicle will undergo real-world testing in active mine sites to gather performance and sustainability data. This project supports efforts to reduce Scope 1 and 2 emissions, enhances safety, and lowers long-term operating costs. The F-250 electrification marks a key step toward transforming heavy-duty fleets with clean, efficient, and future-ready vehicle solutions for the mining industry.

3:05 pm

Advancing Industry Interfaces Through Collaboration: Dynamic Charging Systems

T. Litkenhus; Caterpillar, Inc., Tucson, AZ

This presentation will explore how industry collaborations are advancing interoperability principles for onboard dynamic charging systems. Join Caterpillar Vice President Thad Litkenhus for a thought-provoking discussion on mining innovation and the engagement to align on industry-common technical interfaces (electrical, mechanical and communication) for dynamic charging systems. Throughout the session, attendees will learn more about the proposed interface requirements informed by OEMs and safety protocols for dynamic charging. The intention of the presentation is informing the mining community of an existing initiative and to solicit feedback.

3:25 pm

Powering the Future Underground: Overcoming Safety and Infrastructure Barriers with Epiroc BEVs in U.S. Mining

E. Fernandez; Epiroc, Broomfield, CO

Epiroc's Battery Electric Vehicles (BEVs) are redefining underground mining by cutting ventilation needs up to 40%, reducing heat load, and eliminating diesel particulates. Their adoption, however, depends on overcoming infrastructure challenges such as integrating with legacy power systems, managing charging in restricted drifts, and ensuring compliance with MSHA standards. This presentation examines real-world deployments of BEV LHDs and trucks, addressing battery safety, charging logistics, and grid readiness. Emphasis is placed on mine-ready charging solutions that enhance fleet utilization and unlock the full safety, efficiency, and productivity benefits of electrification. Attendees will gain practical insights for designing BEV-ready operations at scale.

Wednesday, February 25 Afternoon

MINING & EXPLORATION: MANAGEMENT: RISK MANAGEMENT AND CATASTROPHIC PROPERTY LOSS PANEL

255C

Chair: ***M. Meighen****, Sigma 7 Risk, Girard, PA*

2:00 pm

Introductions

2:05 pm

Risk Management and Catastrophic Property Loss

M. Meighen[1] and D. Vana[2]; [1]Sigma 7 Risk, Girard, PA and [2]Hub International, Chicago, IL

Catastrophic property loss in the mining industry occurs with severe damage to mining facilities, equipment, infrastructure, surrounding land and communities, resulting in significant financial losses, environmental devastation, and potential loss of life. Noted events include tailings dam failures, ground collapse, equipment and infrastructure failures, fires and explosions, and natural disasters. Events may be mitigated with risk management controls and financial loss limited with proper enterprise risk management coverage. A panel discussion on risk management reviews and coverage will explore this subject along with audience Q&A.

Wednesday, February 25 Afternoon

MINING & EXPLORATION: OPERATIONS: MY MINE, MY PROJECT - AN UPDATE ON ONGOING OPERATIONS AND UPCOMING PROJECTS

255E

Chairs: ***T. Ferreira****, Dyno Nobel, Queen Creek, AZ*
I. Ateng*, Nevada Gold Mines*

2:00 pm

Introductions

2:05 pm

Efficiencies of Scale: Implementing Larger Underground Stoping and Equipment at Nevada Gold Mines

B. Farbridge and D. Cadwell; Nevada Gold Mines, Elko, NV

Goldrush (GRUG) represents a step change in underground mining for Nevada Gold Mines, with significantly larger stopes and equipment compared to the incremental size increases seen at other Nevada operations. We will present the efficiency gains and challenges associated with implementing large scale mining at GRUG. The presentation will highlight improvements in material handling, bulk longhole stoping, as well as the operational and infrastructure challenges of integrating large-scale equipment while developing NGM's newest underground mine.

2:25 pm

Advancing a Modern, Efficient Copper Mine on Private Land in Arizona

G. Kuntz and C. Shaw; Ivanhoe Electric, Herriman, UT

The Santa Cruz Copper Project presents a new model for modern and efficient copper mining in the United States. This 100%-owned, privately held site integrates high-grade underground mining with chloride heap leaching to produce pure copper cathodes, eliminating the need for smelting and tailings. Designed with a small surface footprint and powered by up to 70% renewable energy, the project features efficient material handling, advanced water management, spent ore repurposed as paste backfill, and modern technologies. Simplified permitting enables near-term construction and a timeline for first copper cathode production by the end of 2028. The Santa Cruz Copper Project serves as a blueprint for modern, capital-efficient, low-impact, and high-efficiency mineral development, supporting American supply chain resilience

2:45 pm

Santa Cruz Mine Power Feed PFS

D. Richards[1], C. Shaw[2] and E. Castleberry[2]; [1]Burns & McDonnell, Phoenix, AZ and [2]Ivanhoe Electric, Casa Grande, AZ

The Santa Cruz Copper Project in Arizona will be at the leading edge of innovation and sustainability. To achieve this, the project plans to source power through a combination of green energy purchased from the grid and a suite of onsite energy generation and storage technologies. This presentation will highlight findings from a recently completed Preliminary Feasibility Study, prepared under United States regulatory requirements. The study evaluated onsite solar, lithium-ion battery energy storage system (BESS), vanadium redox flow battery (VRB-ESS), and the associated infrastructure needed to support the onsite renewable energy campus. Key considerations included system sizing, operations strategies, cost analyses, and utility provider constraints. Additionally, a modular pilot system for VRB-ESS that is in development will be discussed.

3:05 pm

Reviving Virginia's Heavy Minerals Mines

K. Tew, E. Kolbet and A. Gebhart; Atlantic Strategic Minerals, Stony Creek, VA

Atlantic Strategic Minerals (ASM) is the newest heavy mineral sands operation in the United States. The current deposit is rich in Zircon, Titanium, and contains the rare earth feedstock Monazite. ASM is comprised of two brownfield processing sites and a new mine operating south of Richmond, VA. The operation is unique in that the timeline from mined to returned to landowners is approximately 7 years. The operations itself balances unique low impact mining methodology and mineral processing. ASM is expanding its operations, conducting drilling campaigns, and is in the process of going through the feasibility for a new circuit and new operation. In this presentation we will explore the process of upgrading the existing mills, commissioning a new mine site, the progress on upcoming projects, and the overall uniqueness of heavy mineral sand mining.

Wednesday, February 25 Afternoon

MPD: CHEMICAL PROCESSING: HIGH PRESSURE, HIGH TEMPERATURE, AND PYRO-METALLURGY

155A

Chairs: ***R. Frischmuth****, Hatch, Mississauga, ON, Canada*
C. Subasinghe*, PennState University, State College, PA*
E. Konadu-Yiadom*, Colorado School of Mines, Golden, CO*

2:00 pm

Introductions

2:05 pm

Experimental and Computational Development of Erosion Resistant Impeller Technology

J. Giacomelli, B. Boyer and T. Bulchandani; SPXFLOW, Palmyra, PA

Hydrometallurgical applications conducted in autoclaves such as POX and HPAL rely on an impeller to suspend solids and disperse gas. These applications are notoriously hostile to impellers in terms of blade erosion and impeller replacement can drive shutdown schedules negatively impacting production economics. To develop new impeller geometries capable of resisting erosion and extending blade lifetime, we have developed an accelerated erosion test rig in which impellers are mixed with Al2O3 particles at similar collision energies to full-scale to study effects of blade geometry on erosion rates. To ensure that the lab-scale blade-particle interactions are representative of full scale, we developed and validated a mechanism for scaling erosion using this test rig. This talk will focus on presenting our test rig and how it is currently being used to develop new impeller technology.

2:25 pm

Overview of the Morenci Concentrate Leach Plant Expansion Project

R. Frischmuth[1], A. Banda[2] and A. Matthews[1]; [1]Hatch, Mississauga, ON, Canada and [2]Freeport McMoRan, Morenci, AZ

The Morenci concentrate leach plant (CLP) was initially commissioned and operated in late 2007 operating at partial sulfide oxidation, medium-temperature direct electrowinning conditions. The plant was shutdown in mid-2008 primarily due to low copper prices. Favorable copper economics and the additional benefit of acid production for heap leach operations justified refurbishment and recommissioning of the plant in May 2015. The recommissioning included assessment and modifications to operate applying complete sulfide oxidation, high-temperature conditions (HT). An initial capacity assessment study in 2021 identified an opportunity to increase capacity from the current operations at 22 t/h (24 st/h) to 36 t/h (40 st/h) without modifying the two pressure leach vessels (PLV). Additional studies identified significant modifications required for the off-gas circuit and oxygen plant capacity and other minor modifications. Execution of Morenci CLP Expansion Project was initiated in early 2023 and the full expansion construction from March 2025 to June 2025. This presentation provides an overview of the Morenci CLP expansion project modifications, construction, commissioning, and start-up.

2:45 pm

Novel Pressure Leach Agitator Configuration Results in Improved Gas-Handling Capacity and Reduction in Reactor Fouling

A. Iñiguez[1], R. Frischmuth[2], A. Banda[3] and J. Giacomelli[1]; [1]SPXFLOW, Palmyra, PA; [2]Hatch, Toronto, ON, Canada and [3]Freeport-McMoRan, Morenci, AZ

The Morenci Cu concentrate leach plant (CLP) applies oxidative pressure leach technology to leach Cu from concentrates into solution for recovery to cathode. Pressure leaching occurs in two autoclave trains that operate at elevated temperature and pressure with high purity O2 addition. The initial plant design, commissioned in 2007, included dual up-pumping A340 impellers to provide the required O2 mass transfer and mixing (Mardsen 2007). In 2023 Freeport-McMoRan Morenci Inc (FMI) initiated execution of the CLP Expansion Project with the goal of increasing throughput while utilizing the available autoclave process volume. The study phase of the project focused on evaluation of the agitators in the first three stages to support the planned increase in O2. SPX FLOW conducted testing and CFD modeling which resulted in the development of a novel agitator design that has an A320 down-pumper above an A340 up-pumper. The design was tested and found to be capable of handling the increased gas flow rate and reduce splashing without major modifications to the existing agitator (gear drive, shaft). The development and successful operational outcomes of the upgrade will be presented.

3:05 pm

Risk Mitigation Strategies for Restarting Hydrometallurgical Facilities: Lessons from the Lone Tree Project

L. Coleman and W. McCombe; Hatch, Toronto, ON, Canada

A growing trend in the mining and hydrometallurgical sector involves the evaluation and execution of restart projects for previously operating facilities. These initiatives offer advantages in terms of capital efficiency by leveraging existing infrastructure such as equipment, foundations, and utilities—often resulting in lower costs compared to greenfield developments. Restart projects are a subset of brownfield projects and carry a unique set of risks. These risks tend to escalate with the duration of plant inactivity, as changes in technology, undocumented modifications, and asset fitness introduce uncertainty and complexity into engineering and execution phases. This paper examines the inherent challenges of restart projects through the lens of the Lone Tree Restart project. It outlines early-stage activities that can effectively mitigate risk, including multi-disciplinary site walkdowns and condition assessments. The importance of detailed field verification to support engineering deliverables is emphasized. Finally, the paper presents key lessons learned by the Lone Tree project team, offering practical guidance to improve outcomes and reduce risk in future restart efforts.

3:25 pm

Field-Proven Engineering Modifications to Improve Isolation Valve Reliability in Pressure Oxidation

E. Ng; Callidus, a Score Company, Balcatta, WA, Australia

A comprehensive valve upgrade strategy was developed to extend the service life of isolation valves operating in aggressive POX environments. Central to this approach was a novel dual-layer coating system featuring a dense, inert metallurgical base layer fused to the substrate, combined with a hard oxide topcoat to resist corrosion and erosion. Complementary enhancements included upgrading gasket material to improve sealing reliability under cycling and chemical exposure, as well as the addition of a weld inlay using corrosion-resistant alloys. Field validation demonstrated a significant increase in operational lifespan, reduced maintenance, and improved reliability in oxygen-rich, high-temperature acidic service conditions.

3:45 pm

Study on the Distribution of Precious Metals During the Lead Refining Process

C. Colligan and J. Lee; Colorado School of Mines, Golden, CO

In the secondary lead industry, low concentrations of precious metals are typically not recovered separately due to higher cost. However, in the pyrometallurgical refining of lead bullion with significant precious metal content, these can be economically recovered. To evaluate the feasibility of integrating precious metal recovery into secondary lead production, a series of experiments were carried out to assess the distribution behavior of these metals between the litharge slag and the doré phase. This study involves equilibrating a mixture of litharge slag (1 g) and silver (1 g), supplemented with additional precious metals (e.g., Au, Pt, Pd, Rh, Ru, Os, Ir), under controlled atmospheric conditions. Post-equilibration, the phases were analyzed to determine the partitioning of each metal between the slag and metallic product. Experiments were performed using alumina crucible in a vertial tube furnace between 900°C and 1100°C. The system was held for four hours and the crucible was rapidly quenched to preserve the high-temperature phase distribution. The quenched materials were analyzed by SEM, XRD, and ICP to investigate the distribution of precious metals.

4:05 pm

Current Trends With New Copper Smelters Under Development

D. Connelly; METS Engineering Group, Perth, WA, Australia

Copper smelters are currently experiencing historically low TC/RC and at the same time improved prices for sulphuric acid with significant declines in smelting activity. South East Asia and more particularly China dominates in copper smelting capacity and innovation with new technology. Indonesia is playing a more important role as a result of legislation prohibiting the export of unprocessed concentrates. This paper was the result of a request to evaluate the process options for a new copper smelter considering the technologies available in the market place. The study looked at Chinese Bottom Blown Furnaces (BBF), Double Flash (DF) and Top Submerged Lance (TSL) and a possible hydromet options. Smelting is more efficient than any hydromet option so was quickly ruled out of further consideration. TSL was considered to be only for projects smaller than 200,000 tpa of anode metal. The new smelters in Indonesia PT Freeport and PTAMMAN are both Double Flash. The findings of the study are outlined in this paper. The key drivers were considered to be energy efficiency, minimal environmental impact and slag cleaning technology.

Wednesday, February 25 Afternoon

MPD: CHEMICAL PROCESSING: RARE EARTH AND CRITICAL MATERIALS II

151G

Chair: ***A. Chandra****, USA Rare Earth, Denver, CO*

2:00 pm

Introductions

2:05 pm

Photothermal Evaporation Coupled with Hydration-Controlled Adsorption for Selective Lithium Recovery

Y. Pan and W. Zhang; Virginia Tech, Blacksburg, VA

Solar-driven evaporation offers a scalable and energy-efficient route for lithium recovery from saline water, yet suffers from slow kinetics, low selectivity, and ion interference. Here, we report a bilayer Mo-LDH@Sponge composite that couples photothermal evaporation with hydration-controlled adsorption for selective lithium extraction. Upon solar heating, a dynamic two-stage process is observed: initial thermal input accelerates ion transport and water evaporation, followed by a hydration-driven suppression of Li ions uptake. Elevated temperatures induce more compact hydration shells around Li ions, increasing viscosity and hindering diffusion through stronger ion–solvent interactions. This highlights a hydration-regulated adsorption mechanism. Meanwhile, high salt concentrations reduce interfacial water cohesion, further facilitating evaporation and promoting concentration-driven Li ions migration. The composite achieves strong lithium selectivity over competing cations, robust structural integrity, and stable photothermal performance, providing new mechanistic insight and material design guidance for efficient, sustainable lithium recovery under solar-driven conditions.

2:25 pm

Optimizing the Separation and Purification of Rare Earth Elements with Functionalized Low-Cost Adsorbents

B. Schroeder, E. Sadler, P. Sarswat and M. Free; University of Utah, Salt Lake City, UT

The separation of Rare Earth Elements (REEs) through traditional means remains one of the primary barriers to meeting current market demands for REEs in critical sectors such as electric vehicles and defense technologies. We propose a new method of REE separation and purification which utilizes low-cost polymer substrates such as cellulose or polyester functionalized with organophosphonate acids to adsorb REEs in an initially dilute mixed solution. In this work, we aim to explore the relevant dynamics of the functionalized adsorbents as well as ways of optimizing their performance for the purposes of REE purification and demonstrate the production of high-purity lanthanide salts through this method.

2:45 pm

Pilot-Scale, Modular Research Facility for Acidic Water Pollution Cleanup and Domestic Production of Critical Minerals for National Security

S. Pisupati, M. Rezaee, H. Jammulamadaka, R. Chebrolu, E. Ajiboye, C. Mansani and S. Torabi; The Pennsylvania State University, University Park, PA

A recent study by Penn State researchers revealed that Pennsylvania AMD streams originating from abandoned mines and coal refuse piles of the lower Kittanning coal seam contain the most valuable heavy rare earth elements. Penn State has developed a three-stage process to recover these critical minerals, tested it for proof of concept, and secured a patent. Funded by the US DOE, a modular pilot-scale research and development unit has been designed and built to process 1,000 gallons per day of AMD from a site managed by the Pennsylvania Department of Environmental Protection (PA DEP). The system will selectively recover iron, aluminum, rare earth elements, and cobalt-nickel-manganese concentrates from AMD, followed by a proprietary downstream purification process. These operations aim to produce concentrates of critical minerals while treating acid mine drainage to meet environmental standards and evaluate different feedstocks. This presentation will describe the design, operation, and innovations of the proposed process and pilot facility, emphasizing its role in promoting sustainable recovery of critical minerals from legacy waste streams.

3:05 pm

Development of a Metathesis Process for Rare Earth Element Purification and Recovery: Alternative Pathways for Reduced Energy and Reagent Use

S. Evans[1], O. Wong-Branscome[1], K. Strickland[1], T. Larochelle[2], P. Ziemkiewicz[3] and A. Noble[1]; [1]Virginia Tech, Blacksburg, VA; [2]L3 Process Development, Trois-Rivières, QC, Canada and [3]West Virginia University, Morgantown, WV

Conventional processing of rare earth elements (REEs) often uses oxalic acid to precipitate RE-oxalates from low pH strip solutions. These insoluble oxalates are then calcined to generate soluble RE-oxides, which are either re-leached and further processed or sometimes sold as end products. As an alternative approach, we have developed and tested a metathesis process whereby RE-oxalates are directly converted to RE-carbonates in a single reaction step. The soluble RE-carbonates are suitable for downstream re-leaching, and the metathesis reaction generates an oxalate-rich solution, which can be recycled to other processing steps. The net result avoids costly roasting and oxide leaching stages and provides a pathway for reduced energy and reagent use. This presentation will describe the laboratory process development and potential engineering applications for an REE separation facility leveraging acid mine drainage feedstocks.

3:25 pm

Sustainable Recovery of Rare Earth Elements from Magnet Swarf: Possible?

A. Cueva Sola; Argonne National Laboratory, Lemont, IL

Rare earth elements (REEs) are critical to technologies in energy, aerospace, and automotive sectors, yet the U.S. relies entirely on imports for its REE supply. Mining and primary extraction face environmental and economic challenges, making industrial recycling a promising route to secure a domestic, circular supply chain. Magnet swarf, a metallic waste from machining permanent magnets, is a valuable but underused feedstock containing up to 35% rare earths (Nd, Dy, Pr, Tb) and about 50% iron. The high iron content complicates traditional separation methods that use concentrated acids, generating hazardous waste and increasing costs and risks. This work introduces a two-step, acid-free process to separate iron from magnet swarf while preserving REEs. This method simplifies downstream separation, reduces environmental impact, and enables efficient recovery of rare earths and iron. The scalable, economical process advances sustainable resource recovery, boosting supply chain resilience and circular economy goals in mining and materials sectors.

3:45 pm

Quantifying the Critical Mineral Potential of Secondary Sources: Use of Standard Reference Materials to Build Confidence in Analytical Assays

C. Eyzaguirre[1], L. Fahle[1], C. Smith[1], D. Wellman[1], S. Ulrich[2] and J. Gillow[2]; [1]Rio Tinto, South Jordan, UT and [2]Arcadis, Greenwood Village, CO

There is an urgent need for critical raw materials for future intelligence, defense, and energy technologies; Meeting this demand will require relying on primary ores and secondary (waste-derived) materials. The complexity of waste matrices and analytical challenges makes estimating these resources difficult, often leading to questionable data that can undermine strategic decision-making. This presentation reports on the use of standard reference materials for rare earth elements, semiconductors, transition metals, and platinum group metals to evaluate the reliability of laboratory analytical data for critical minerals. It provides recommendations for best practices to enhance data accuracy and support targeted beneficiation efforts.

4:05 pm

Process Intensification of Nickel Extraction Using CO_2-Attrition-Assisted Systems: Role of Solid Concentration and Agitation Speed

K. Ofori and L. Pan; Michigan Technological University, Houghton, MI

Integrated critical metal recovery and CO_2 based leaching offer a path to carbon-negative mining. This study examines an attrition-assisted carbonation-leaching process that enhances nickel (Ni) extraction from silicate-rich minerals under hydrothermal conditions. Key parameters including solid concentration, temperature, agitation speed, and grinding media were systematically investigated. Attrition improved carbonation and Ni extraction up to 64% in 2 h using -212 μm sample. Compared to regular agitation, attrition yielded faster kinetics. SEM/STEM revealed distinct morphologies of magnesite and amorphous silica formation, and a diffusion-limiting layers in non-attrition systems. The findings show the benefits of mechanochemical action for efficient carbonation-assisted metal recovery.

4:25 pm

The Process Options For Antimony Ore From Alaska

D. Connelly; METS Engineering Group, Perth, WA, Australia

Antimony is listed as a critical and strategic mineral to US economic and national security interests by the US Department of Energy (DoE). Antimony is a semi-metallic element used in alloys to increase hardness, in flame retardants for plastics and textiles and as a dopant in semiconductors and applications such as batteries and military equipment. Antimony is typically extracted from the sulfide mineral stibnite (Sb_2S_3), with lower grades concentrated by froth flotation, leaching and higher grades roasted and smelted. The work undertaken for this antimony project included conducting research of available industry and literature regarding potential antimony processing options for the Estelle antimony ore in Alaska. It also included metallurgical testwork on samples of diamond drill core and assessment of the potential antimony markets. The results of the work are outlined in this presentation. China is a dominant producer of antimony and recent export trade restrictions have seen prices exceeding US$40,000/ton as the supply shortage increased.

Wednesday, February 25 Afternoon

MPD: CHEMICAL PROCESSING: SPECIAL TOPICS IN CRITICAL METAL EXTRACTION

155F

Chair: ***X. Yang****, University of Utah, Salt Lake City, UT*

2:00 pm

Introductions

2:05 pm

Redox-Driven Separation of Manganese from Complex Geothermal Brines for Battery Applications

C. Subasinghe and M. Rezaee; PennState University, State College, PA

Manganese (Mn) is a critical material for battery cathodes, yet its sustainable sourcing remains a challenge. This study presents a scalable approach for Mn recovery from post-condensation geothermal brines from the Salton Sea, which contain >1200 ppm Mn and high total dissolved solids. Using oxidative precipitation with persulfates at near-native brine conditions (pH ~5.5), >99% Mn was selectively removed. The precipitate was further processed to battery-grade Mn through targeted leaching and impurity separation. The product's composition and morphology were confirmed by ICP, XRD, and SEM-EDX. This method advances geothermal brines as a viable domestic Mn resource for clean energy technologies.

2:25 pm

Silver Mobility in Chalcopyrite: Implications for Catalytic Leaching

S. Forbes[1], I. Barton[1], N. Rolston[3] and A. Thorarinsdottir[2]; [1]University of Arizona, Tucson, AZ; [2]University of Rochester, Rochester, NY and [3]Arizona State University, Tempe, AZ

Chalcopyrite ($CuFeS_2$) is the most abundant copper ore globally but remains one of the most difficult to leach efficiently through current hydrometallurgical methods. Recent studies have explored silver's catalytic role in improving leach kinetics, though efforts have largely relied on external silver addition. However, evidence from other copper minerals suggest that silver may readily migrate through solid-state diffusion or electromigration under light or electrical stimuli. This study investigates trace element distribution and potential for intrinsic silver mobility within a natural chalcopyrite sample. Electron microprobe analysis (EMPA) was used for elemental mapping and focused ion beam scanning electron microscope (FIB-SEM) to prepare ultra-thin cross sections for transmission electron microscopy (TEM). Results offer insight into nanoscale pathways for silver transport and trace substitutions, with implications for designing a more effective leaching technique.

3:05 pm

Improving the Understanding of Iodide-Assisted Leaching of Chalcopyrite Concentrate in Acidic Chloride Solution

A. Videla and C. Martinez-Bussenius; Pontificia Universidad Catolica de Chile, Santiago, Chile

Chalcopyrite leaching has slow kinetics in sulfate media due to a passivation layer generated during the mineral's dissolution and/or by its semiconductor properties. Late studies have shown that applying iodide in sulfate media led to a significant improvement in the leaching rate of copper from chalcopyrite. However, no detailed information on the effect of the chloride concentration in this system has been informed so far. In this present work, the leaching of a chalcopyrite concentrate using iodide in chloride solution was evaluated, varying parameters such as temperature, particle size, the initial potential of the solution, chloride, iodide, and cupric ion concentrations. Copper extraction over 70 % in 30 days in the presence of 50 g/L chloridea, 100 mg/L I^-, 0.5 g/L Cu^{2+}, 9 g/L Fe^{3+}, 1 g/L Fe^{2+}, pH = 1.5, 35 °C have been achieved. An evaluation of different factors show temperature, iodide concentration, and chloride concentration as the most important. The chalcopyrite potential obtained for the central condition of this study indicates that the predominant iodine species was triiodide, which suggests that this was the main oxidant in this system.

3:25 pm

Optimizing Ga and Ge Recovery from Secondary Sources

W. Hartzell, M. Moats and L. Alagha; Missouri University of Science and Technology, Rolla, MO

Gallium and germanium present challenges in solvent extraction due to their aqueous chemistry and competition from co-occurring metals such as iron and zinc. Gallium is essential in semiconductors, LEDs, and high-frequency electronics, while germanium is a key component in fiber optics, infrared optics, and photovoltaic systems. With global demand rising, due to advancements in green energy and digital infrastructure, efficient recovery from secondary sources like industrial residues is increasingly important. Understanding pH-dependent extraction behavior enables process optimization and improved selectivity in separating Ga and Ge from complex mixtures. This presentation explores the equilibrium pH vs extraction curves for gallium, germanium, iron, and zinc, examining the underlying mechanisms that govern separation using organophosphorus and hydroxyoxime extractants. These insights support the development of sustainable recovery strategies critical to meeting future technological and economic needs.

3:45 pm

Leaching Kinetics of Sulfide Flotation Concentrates in Ferric Iron Solutions

N. Duru; Rio Tinto, Bluffdale, UT

This paper presents two case studies evaluating the leaching behavior of flotation concentrates by applying ferric leach based hydrometallurgical processes. The first case examines the leaching kinetics of a copper–zinc concentrate of chalcopyrite and sphalerite in ferric sulfate media, where pyrite present in the ore acts as a galvanic catalyst to enhance copper dissolution under atmospheric, moderately heated, and acidic conditions. The second case study investigates a ferric chloride leaching process applied to copper–molybdenum concentrates. In this system, chalcopyrite is selectively dissolved while molybdenite remains largely unreactive, enabling copper removal prior to downstream molybdenum recovery.

4:05 pm

Integrating Carbon Mineralization of Olivine with Recovery of Critical Minerals: A Green Approach

S. Ghaderi[1], W. Zhang[1], N. Zhang[2], A. Park[2], A. Moment[2], B. Limb[3], J. Quinn[3], J. Meng[5], S. Das[4] and H. Xu[6]; [1]Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA; [2]UCLA, Los Angeles, CA; [3]Colorado State University, Fort Collins, CO; [4]Phinix LLC, Clayton, MO; [5]Virginia Department of Energy, Charlottesville, VA and [6]Ultool LLC, Duluth, GA

The extraction of critical minerals from olivine is emerging as a sustainable method for resource recovery. This dual-purpose research investigates the employment of supercritical carbon dioxide and sustainable chelating agents to enhance the selective leaching of critical minerals, such as nickel, from olivine. Integrating supercritical carbon dioxide with green chelating agents not only provides opportunities for carbon mineralization but also enhances the selectivity of Ni leaching in an environmentally friendly system. Experimental findings suggest that using a grinding medium combined with optimized factors, including CO_2 partial pressure, temperature, time, and ligand choice, significantly enhances recovery rates while minimizing impurity dissolution. Overall, this method offers a promising and environmentally friendly alternative to traditional acid leaching techniques, paving the way for sustainable recovery of critical minerals.

Wednesday, February 25 Afternoon

MPD: FLOTATION: FLOTATION FUNDAMENTALS

155C

Chairs: ***T. Gupta****, MP Materials, Mountain Pass, CA*
L. Pan*, Michigan Technological University, Houghton, MI*

2:00 pm

Introductions

2:05 pm

Pyrite Management: From Diagnostics to Reagent Solutions

F. Zeng, M. Lancaster, J. Garcia, G. Sampayo, D. Qualls and E. Arinaitwe; Syensqo, Stamford, CT

Pyrite reporting to concentrate remains a great challenge in the flotation of Cu, Cu-Au, Cu-Mo, and polymetallic sulfide ores, impacting concentrate quality and downstream processing. This presentation provides a review of the mechanisms driving pyrite flotation, diagnostic approaches, and advances in pyrite rejection strategies. Case studies are presented to demonstrate the effectiveness of pyrite depressants in flotation operations, with a particular focus on the performance of AERO 7261A and AERO PR-7500. In addition, test results on the performance of new ultra-selective collectors are presented, demonstrating significant improvements in pyrite rejection and copper concentrate grade.

2:25 pm

Cavitation Tubes for Flotation Pre-Aeration and Gangue Mineral Depression for a Bastnasite Concentration Application

C. Ratliff, B. Ji and R. Honaker; University of Kentucky, Lexington, KY

Pre-aeration of flotation feed has previously been shown to enhance recovery of valuable particles that are smaller than the lower size limits of a froth flotation process. The mechanism involves nucleation of nanobubbles on the hydrophobic surfaces followed by particle-particle agglomeration that results from air serving as the bridging medium. The impact on improving the flotation recovery of -20 micron bastnasite particles has been measured and confirmed in laboratory tests by processing conditioned slurry through a cavitation tube prior to flotation. However, an additional benefit realized in this application was the depression of gangue minerals including calcite, which resulted in an increase in rare earth grade by about 20 percentage points and a significant decrease in mass yield reporting to the concentrate. The results have been confirmed by elemental analysis and x-ray diffraction studies. The findings will be presented and discussed along with a vision for commercial implementation.

2:45 pm

Applying an Atomic Force Microscope for the Study of In-situ Adsorption of Collectors on Malachite

J. Zhang; The University of Arizona, Tucson, AZ

Atomic force microscopy (AFM) has been applied to study the in-situ the adsorption of various general flotation collectors, i.e., octanohydroxamate (OHA), potassium amyl xanthate (PAX), dithiophosphate, mercaptobenzothiazole (MBT), on malachite in aqueous solutions. AFM images show that most of these collectors adsorb strongly on malachite except for PAX. Increasing the collectors' concentration and the adsorption time both increase the adsorption on malachite. The findings are in line with what has been observed with the study of attenuated total reflectance–Fourier transform infrared spectrometry (ATR-FTIR). The present study shows that the collectors, i.e., hydroxamate, dithiophosphate and MBT, and/or their mixtures can be used for the direct flotation of malachite, while sulfidization is needed when xanthate is used. The present study show that AFM image analysis is a powerful tool for the study of the collectors' in-situ adsorption on malachite surface and it can help with the development of novel collectors for the flotation of malachite and other copper oxide minerals.

3:05 pm

Collector Blends for the Flotation of Rare Earth Silicates

P. Amankwah; Montana Technological University, Butte, MT

Collector Blends for the Flotation of Rare Earth Silicates Padmore Amankwah[1] (presenter), Rick LaDouceur[2], and Courtney Young[1] (advisor) 1 Metallurgical and Materials Engineering, Montana Technological University 2 Mechanical Engineering, Montana Technological University Fundamental studies have shown that Rare Earth Mineral (REM) flotation is dependent on Lanthanide Contraction (LC) and Coordination Number (CN) of their Rare Earth Element (REE) content. This is also true for Rare Earth Silicate (RES) flotation; however, Silicate Polymerization (SP) is a related factor such that different silicates do not give the same flotation response (e.g., sorosilicates vs orthosilicates). To help delineate this behavior, samples from the Halleck Creek Property in Wyoming were obtained and either used as is or gravity preconcentrated with a spiral. Various collectors were examined individually and as blends including but not limited to Salicyl Hydroxamic Acid (SHA), Benzoic Acid (BA), and Phthalic Acid (PA). Feeds and resulting cons and tails were characterized using SEM/EDX/TIMA, ICP OES, XRF and XRD to determine flotation responses. Optimal flotation was achieved with collector blends.

3:25 pm

Not a "One Size Fits All" - Addressing the Deficiencies and Misconceptions of Xanthate

N. Bellusci and M. Lancaster; Syensqo, Stamford, CT

Over the past 70 years, alkyl xanthates have been the most widely studied collectors in sulfide flotation. However, the large number of fundamental studies on xanthate is in stark contrast to current plant practice, where many non-xanthate ligands are used; this is because of the inherent non-selectivity of xanthate and because it is not a "one size fits all." In addition to these empirical observations, the proposed electrochemical adsorption mechanism of xanthate is subject to scrutiny because the conditions used in past fundamental studies involve high xanthate concentrations, single "pure" minerals, and wide potential ranges - none of these are relevant to plant practice. In this study, we demonstrate with real ore flotation that xanthate can be an inappropriate collector choice in terms of selectivity and unable to recover all value minerals on its own. We also demonstrate with voltammetry that xanthate does not become oxidized under conditions relevant to plant practice, but instead simply passivates the mineral surface. These findings provide fundamental and practical guidelines in designing and selecting collectors for sulfide flotation.

3:45 pm

Role of Different Gangue Minerals on Pyrrhotite Flotation

O. Agbelusi, K. Huang and L. Pan; Michigan Technological University, Houghton, MI

MgO-bearing gangue minerals can hamper recovery and product grade in the nickel sulfide flotation. In this study, we have investigated three common gangue minerals, i.e., olivine, dunite, and gabbro, and their impact on pyrrhotite flotation. Binary separation tests between pyrrhotite and gangue minerals have been conducted systematically. The results show that gabbro has little impact on pyrrhotite flotation, while pyrrhotite recovery is substantially compromised in the presence of olivine and dunite. It is found that heterocoagulation between dunite and pyrrhotite leads to low pyrrhotite recovery, while the natural hydrophobic species such as talc in olivine may affect the pyrrhotite grade.

4:05 pm

Advances in Cu-Mo Separation: Implementation of AERO® NR-7361 as a Copper Sulfide Depressant

A. De La Rosa[1], M. Pineda[2], R. Garcia[2] and E. Arinaitwe[1]; [1]Syensqo, Tempe, AZ and [2]Orion Productos Industriales, S.A. De C.V., Guanajuato, Mexico

Molybdenite is typically recovered as a co-product with copper in bulk flotation circuits. In the subsequent copper-molybdenum (Cu-Mo) separation stage, molybdenite is separated from copper sulfides and pyrite by selectively depressing these minerals, commonly using inorganic reagents such as sodium hydrosulfide (NaSH). Because collectors bind strongly to copper mineral surfaces, the usage of NaSH to maintain highly negative (reducing) oxidation-reduction potentials (ORP) is usually required for effective depression. Recent plant studies have shown that AERO® NR-7361 depressant can achieve efficient separation at much less negative ORP compared to traditional NaSH-based processes. This paper presents the application of AERO® NR-7361 as a replacement for the incumbent depressant in the Cu-Mo separation circuit at Aranzazu Holding in Mexico. The use of AERO® NR-7361 resulted in a total replacement of the incumbent depressant reducing the consumption by about 60% without negatively impacting Mo recovery or r grade of the final molybdenite concentrate. Additionally, this change reduced the risk of hydrogen sulfide (H_2S) generation and associated employee exposure.

4:25 pm

Using Bio-Based Frother to replace Synthetic Options in Various Mineral Applications

L. Kuri; Integrity Mining and Industrial, Humble, TX

Traditional frothers like alcohols and glycol ethers have long been the standard in froth flotation—but as the mining industry faces mounting ESG pressures, operators are seeking sustainable alternatives that do not compromise performance. Current synthetic frothers are carbon-intensive, volatile, and often overused to maintain recovery across variable ore types. Integrity Mining and Industrial developed TegraFroth, a bio-based frother with a Renewable Carbon Index above 75%. Designed for versatility and low dosage efficiency, TF was evaluated in a series of lab and plant trials across coal, potash, copper, and 4E applications. TF has produced favorable results in our internal testing at various facilities. In all internal, third-party, and on-site evaluations, we found an increased recovery, with coal and copper-moly testing showing recovery improvements of over 6%, with consistent or improved grade. TegraFroth represents a scalable and responsible solution for increasing recovery while reducing environmental impact. This presentation will detail our recent performance in plant trials in the Potash and Copper flotation industries that are taking place in Fall 2025.

Wednesday, February 25 Afternoon

MPD: FLOTATION: INTEGRATION OF AI INTO FLOTATION OPTIMIZATION AND CONTROL

155D

Chairs: ***T. Bhambhani****, Stamford, CT*
M. Carlisle*, Newmont, Englewood, CO*

2:00 pm

Introductions

2:05 pm

Maximizing Copper Production while Increasing Water Recovery Using AI-Driven a Digital Twin and Real-Time Data

O. Bascur; OSB Digital, LLC, The Woodlands, TX

The global mining industry faces increasing pressure to process low-grade ores under tighter environmental, energy, and water constraints. Traditional mineral processing operations are energy-intensive and inefficient, often relying on static models or operator experience to guide decisions. The key gap lies in the absence of real-time, intelligent systems capable of dynamically optimizing operations for sustainability while maintaining or increasing metal production and increasing water recovery. While simulation tools exist, they are often offline and disconnected from real plant data. This twin acts as an intelligent advisor, capable of forecasting system behavior and autonomously suggesting control actions for improved sustainability, throughput, and reliability. We review two cases which have resulted in increasing iron production integrating starting at the drilling to the port. And a case of mineral processing plant which struggled to maximize their production for years. After implementing the OSB Digital Twin Plant model, the plant was able to maximize copper production by 32% while increasing the water recovery from the thickener by 40%.

2:25 pm

26-036

Industrial Application of Flotation Pulping Detection with Computer Vision

M. Oosthuizen, A. Coetzee, C. Botha, M. de Leeuw and L. Auret; Stone Three, Cape Town, South Africa

Flotation performance is affected by upstream disturbances (e.g., mineralogy, water quality, flow rate) and controlled variables (e.g., pulp level and air addition). Process disruptions can lead to undesired conditions, such as pulp overflowing flotation cells (with insignificant/absent froth, and thus no valuable mineral concentration). Early detection and appropriate intervention of pulping events improves concentrator performance. An approach to real-time flotation pulping event detection by means of convolutional neural networks is presented, including a case study of the industrial application of this technology on three flotation banks.

2:45 pm

Flotation Recovery Optimisation using a Real-Time Closed-Loop AI Decision System

A. Griffin, J. Labuschagne and B. Topal; IntelliSense.io, Bishop's Stortford, United Kingdom

The global push for electrification requires smarter, more efficient recovery of critical minerals from variable ores. To meet this challenge, IntelliSense.io has deployed a Scientific-AI solution to optimize flotation circuits. This system, combining machine learning with first-principle models, is live at major copper (Chile) and gold (Australia) operations. It delivers real-time virtual sensors and optimized setpoints for airflow, froth depth, and reagent dosage directly to plant control systems. A multi-variable reward function balances operational constraints and priorities. This paper presents the real-world outcomes of this technology.

3:05 pm

Designing an AI Ready Flotation Circuit

C. Anderson; Senior Metallurgist - Jameson Innovation, Brisbane, QLD, Australia

The integration of AI into flotation circuit control is becoming increasingly popular, with plethora of service providers offering various approaches to search out patterns in the data for use in plant optimisation. However, these systems are often limited by the quality of the input data. Relatively little focus is given to the design of flotation circuit such that high quality data can be made available for the APC controller. This presentation demonstrates an approach to flotation circuit design using simple robust sampling and online analysis techniques to deliver a live mass balance of the circuit in preparation for AI implementation.

3:25 pm

Using Automated Mineralogy Data for Optimization of Flotation and Leaching Circuits

P. Miranda; Eagle Engineering, Butte, MT

Automated mineralogy programs such as Mineral Liberations Analysis (MLA), Qemscan, Automated Mineral Identification and Characterization (AMICS), Tescan, and other systems have greatly improved recoveries in both flotation and recovery circuits. The software packages of automated mineralogy packages can deliver all types of data, however, not all received data is required to improve recovery in circuits. This discussion will briefly explain the technology followed by selecting the important selected automated mineralogy data required to increase flotation and leaching circuits. Previous data will be observed along with results from current mining sites and projects.

3:45 pm

Using a First-Principles Flotation Model for Scale-up, Design, and Process Optimization

M. Gupta, K. Huang, A. Noble and R. Yoon; Virginia Tech, Blacksburg, VA

Many investigators rely on laboratory flotation tests to predict plant performance, which is difficult as operating conditions change substantially upon scale-up. Therefore, plant design is usually done via experience and heuristics. One can use models to reduce the number of variables and assumptions; however, the models are mostly empirical and hence cannot predict product grades. In this work, we have tested a first-principles flotation model that can predict the changes in grade vs. recovery curves under different operating conditions. Therefore, it can also be used for process development and optimization. The model predictions have been validated in an operating plant.

Wednesday, February 25 Afternoon

MPD: GEOMETALLURGY: BEST PRACTICES AND CASE STUDIES

Grand Blrm D

Chairs: ***B. Odegard****, Newmont*
J. Villanueva*, Denver, CO*

2:00 pm

Introduction

2:05 pm

Geometallurgy Program at Newmont's Peñasquito Polymetallic Mine

J. Villanueva; Newmont, Mexico City, Mexico

Since 2018, a comprehensive geo-metallurgical program has been implemented at Newmont's polymetallic Peñasquito Mine in Mexico. This program is essential due to the complex and highly variable nature of the orebody, as well as the intricacies of the process plant. Understanding the metallurgical response of the various ore types is critical for accurate production planning, plant optimization, and operational stability. The program involves spatially extensive and representative sampling across the deposit for both flotation and comminution test work, tailored to meet the metallurgical and statistical information requirements of the processing facility. Test work is collaboratively designed by process directors, geometallurgists, and site metallurgists to ensure that the generated data addresses operational challenges and informs actionable solutions. As the geo-metallurgical program matures, a key question arises: how much data is sufficient to meet operational and planning needs? Statistical analysis, can offer insights into optimal data density and the diminishing returns of additional sampling—guiding future strategy and resource allocation within the program.

2:25 pm

Improving Recovery of Sediment-Hosted Vanadium with Geometallurgical and Hyperspectral Mapping

W. Allen[1], I. Barton[1], D. Riley[1] and F. Corrado[2]; [1]University of Arizona, Tucson, AZ and [2]University of Naples Federico II, Napoli, Italy

Vanadium is a USGS-designated Critical Mineral Resource used as a steel hardener and catalyst with additional potential in redox-flow battery technology. However, domestic sourcing of vanadium is challenged by low leach recovery related to complex mineralogy and ore distribution. This research aims to improve vanadium recovery by correlating vanadium-bearing mineral distribution (mapped visually and with hyperspectral imaging) with leach recovery. The study sites are U-V deposits of the Colorado Plateau, which host most of the United States' natural resource of both metals. Vanadium in these deposits occurs most frequently in V-(hydr)oxides and phyllosilicates including illite, roscoelite and chlorite. The phyllosilicate-hosted metal shows variable, but low recovery in tank leaches. Previous research indicates that different hosting mechanisms within the respective phyllosilicates generate leaching recoveries between zero and 30 percent. Visual identification of species is difficult, but supplementation with hyperspectral techniques and persistent mapping campaigns has generated reliable ways to identify areas of higher and lower recovery, facilitating performance prediction.

2:45 pm

Mapping and Modeling Domestic Cobalt and Nickel Mining-Refining Projects

G. Gibbs, J. Kim and E. Holley; Colorado School of Mines, Golden, CO

Due to the US's import reliance on nickel and cobalt, several mining and processing projects have recently been proposed. This research involves a geometallurgical review of the active and proposed domestic nickel and cobalt mines using company technical reports and relevant literature. The review focuses on how the mineralogy of each deposit type affects the proposed processing routes to create a concentrate, which then needs to be refined into a final product. Using these concentrates as feedstock, a conceptual hydrometallurgical flowsheet is modeled in SysCAD, a plant modeling software, to assess the feasibility of a singular domestic refinery.

3:05 pm

Characterization and Processing Challenges of Oxidized Stockpile Ore at the Bingham Canyon Mine

L. Hughes[2] and K. Jones[1]; [1]Rio Tinto Kennecott, West Jordan, UT and [2]Rio Tinto Nuton, South Jordan, UT

As ore deposits become more depleted worldwide, mining companies are often left with challenging ore to process. A common form of challenging ore is oxidized ore that has been stockpiled. Rio Tinto Kennecott's Bingham Canyon mine has increased reclaiming stockpiled ore over the past two years, and blending it in with fresh pit ore. While rehandling and processing stockpiled material ensures that downstream facilities have a consistent feed, it also presents a unique set of challenges in processing. Challenges encountered at Kennecott while processing oxidized stockpile ore have included: reduced overall recovery due to oxidation and nonideal flotation chemistry, increased media and liner consumption, grind sensitivity, and increased flotation reagent consumption. Through detailed characterization and test work, the Concentrator Technical Team has been able to propose a sustainable path forward for the processing of oxidized stockpile material. This presentation details important learnings and the implementation of a new reagent in the plant that shows benefit specific to the stockpile ore.

3:25 pm

26-037

Iron Ore Geometallurgy to Guide Strategic Decisions

H. Turrer[1], J. Mesquita De Souza Junior[1], M. Rodrigues Cruz[1], D. Wonyen[2] and D. Edifor[2]; [1]ArcelorMittal, Maizières – lès – Metz, France and [2]ArcelorMittal Liberia, Yekepa, Liberia

A geometallurgical testing program was developed to anticipate ore behavior in the beneficiation plant and support production planning. Over 100 drill core samples from a major iron ore deposit were tested using bench-scale gravity and magnetic separation methods to assess variability in process responses. Results showed significant differences in key attributes such as iron grade, gangue content, slimes generation, and specific gravity, directly impacting concentrate grade, recoveries, and tailings quality. Correlation analysis and regression models were used to link feed properties to process outcomes, and a mass recovery estimation equation (Wrec) was developed for predictive use. The study proposes the integration of geometallurgical parameters—such as Fe, SiO2, Al2O3, LOI, ore type, size fractions, and slimes content—into the block model to support blending decisions and minimize operational risks. This work establishes a solid foundation for long-term mine-to-plant integration, with future phases aiming to expand testing and build a calibrated geometallurgical model.

3:45 pm

Best Practices on Mine Life Cycle Ore Characterization

K. Cooper, J. Baron, J. Thogerson and C. Dunn; Newmont, Weston, FL

It has been widely recognized that integrating a comprehensive ore characterization program across the mine lifecycle allows for better decisions and minimizes risk to the business and operations. Geometallurgy programs commonly generate large multi-scale datasets involving primary ore properties (e.g. rock texture, modal mineralogy and geochemical composition), secondary processing attributes (e.g. hardness, liberation, leachability, flotation behavior), followed by further characterization of processed material using bulk chemistry or mineralogical techniques. Selecting the appropriate test methods is essential to ensure that the resulting information is both reliable and usable. Data generation without appropriate test method selection can result in misinterpretation, suboptimal implementation, inaccurate ore characterization, or even the omission of critical insights due to inadequate testing. This presentation will explore examples of effective test method selection with a focus on their application to ore characterization and downstream predictive modeling.

Wednesday, February 25 Afternoon

TAILINGS MANAGEMENT: AUTONOMY REVOLUTIONIZING GEOTECHNICAL ENGINEERING

Sponsored by Newmont

155B

Chairs: ***C. Winter****, Cleveland-Cliffs, Inc., Hibbing, MN*
C. Fritsch*, Green Bay, WI*

2:00 pm

Introductions

2:05 pm

Uncertainty in Upstream TSF Stability: Will We Hang Our Hats on Numerical Outcomes?

E. Coyle; Working Engineer, Denver, CO

As more existing upstream tailings storage facilities (TSFs) are held to a higher standard of analysis given recent catastrophic failures and the adoption of the GISTM by many, Limit Equilibrium (LE) stability outcomes are very regularly not returning satisfactory Factor of Safety (FoS) stability outcomes. In this instance, dam owners are typically faced with two options, invest in substantial and costly buttressing exercises, or perform and rely upon less conservative outcomes associated with advanced numerical models. In some instances, buttressing is not possible due to footprint constraints. Where the latter approach is adopted, significant questions are grappled with, both by the dam owner and the EoR, such as; what are the credentials to be a qualified practitioner in the field?, who are the authority for review of such advanced models? The ultimate question asked however, is are we comfortable relying on numerical stability outcomes, when unsatisfactory LE outcomes are found? Through examination of three upstream TSF examples where the numerical approach was adopted, this paper will attempt to answer some of those questions posed above.

2:25 pm

Comparative Analysis of Deformation in Upstream Tailings Dams Using FLAC and PLAXIS

A. Nematzadeh and E. Hsiao; Hatch, Calgary, AB, Canada

The slow consolidation process in an upstream tailings dam can cause noticeable deformations and reduced stability due to increased excess pore pressures during dam raising. Constructing rockfill berms on the downstream side is an effective method to reduce dam deformation and enhance dam stability. Therefore, this study conducted deformation and stability analyses of an upstream tailings dam reinforced with rockfill embankments using both PLAXIS and FLAC under static loading. Finite element and discrete element analyses were conducted to model the staged construction of the dam. The dam was raised in 11 stages, with each stage comprising a raising phase and a consolidation phase. Applying the Norsand and Mohr-Coulomb constitutive models, the results showed that the deformation and stability of the dam decreased due to increased excess pore pressures during the raising phase but improved during the consolidation phases. The results revealed good consistency between PLAXIS and FLAC. This comparison highlights the similarities and differences between FLAC and PLAXIS outcomes, offering valuable insights for future deformation analyses and the design and construction of tailings dams.

2:45 pm

Comprehensive Approach and Criteria to Develop a Tailings Storage Facilities (TSF) Monitoring System

B. PANDA; AECOM, Phoenix, AZ

The failures of tailings dams have exposed the mining industry and surrounding communities to potential severe environmental, human health, and economic consequences from potential structural stability risks. It is very important that the TSFs remain stable throughout the facilities lifecycle and thus it is a top priority of the mining company to find the right product for the monitoring of TSF from the initial construction stage to the final post closure stage. Effective monitoring relies on a multifaceted approach that considers the facility's life cycle, construction method, physical setting, material change, remediation and reclamation and regulatory compliance. This requires a comprehensive approach encompassing various monitoring criteria and should allow for the prediction of potential future failures to ensure TSF safety. The key criteria include monitoring pore pressure, phreatic surface level, embankment movement, water seepage and soil moisture content and establishing alert level. The paper will focus on the use of state-of-the-art monitoring systems using the application of InSAR data from initial construction to post closure.

3:05 pm

Underwater Tailings Deposition via Autonomous Barge

D. Thompson; Coeur Mining, Gilbert, AZ

Coeur Alaska Kensington Mine is currently implementing a tailings deposition barge that has the ability to autonomously deposit fine tailings underwater at our tailings treatment facility. The autonomous tailings barge can effectively maximize tailings storage capacity by sensing the depth of underwater tails at the deposition site and move to a new location once the tailings stack up to a defined valve. The previous deposition strategy was to manually move a floating barge multiple times a day to a new area and try to find a "deep spot" with every move. Not only was our previous method of deposition extremely time-consuming, but it was also a guessing game that created many peaks and valleys that needed to be filled. The main goal for implementation of the new barge is to fill all underwater valleys, leaving a nearly flat lakebed, while also reducing manpower dedicated to tailings management year-round.

3:25 pm

Integrating Artificial Intelligence (AI) into Tailings Management

L. Josic[1] and E. Humphries[2]; [1]Mrs, Mississauga, ON, Canada and [2]Mr, Reno, NV

As global demand for minerals continues to rise, tailings production is increasing significantly each year. It has been estimated that nickel, lithium, and cobalt production need to increase by 150% to supply the electric vehicle and clean energy sectors in the coming years. This significant increase in metals production will result in a corresponding substantial increase in tailings production and the need for proper tailings management. This paper explores the use of Artificial Intelligence (AI) technologies such as machine learning, computer vision, and predictive analytics to enhance the safety, performance, and sustainability of tailings storage facilities (TSFs). AI facilitates real-time monitoring by analyzing data from sensors, drone imagery, and satellite observations to detect early signs of instability or potential failure. By improving situational awareness and supporting timely decision-making, AI enhances overall governance and aligns with the evolving environmental, social, and regulatory expectations. This paper also discusses implementation challenges and the adoption of AI in tailings management systems.

3:45 pm

From Failure Modes to Trigger Levels: A Practical Framework for Tailings Dam Monitoring

T. Dixon; GHD, Vancouver, BC, Canada

This presentation introduces a structured framework for identifying failure modes in tailings dams and translating them into effective monitoring and trigger level strategies. It combines theoretical insights from hands-on workshops to equip engineers, geotechnical specialists, dam operators, and regulators with practical tools for improving dam safety. The presentation will explore failure mechanisms to select appropriate quantifiable performance objectives, and develop trigger levels to support proactive risk management. Real-world case studies to highlight the importance of informed decision-making will be presented, reinforcing the application of monitoring strategies in diverse site conditions. Attendees leave with a deeper understanding of failure mode assessment, instrumentation planning, and trigger level development—ready to apply these skills to enhance the safety and resilience of tailings dams.

4:05 pm

Panel Discussion After Presentations (if time allows)

Wednesday, February 25 Afternoon

VALUATION: LESSONS LEARNED & BEST PRACTICES

150D-E

Chairs: ***Z. Smith****, Withum, Jersey City, NJ*
H. Cahill*, Cahill Mining Consulting*

2:00 pm

Introductions

2:05 pm

Current Issues in Energy and Mining Valuation

2:45 pm

Appraisals of Oil and Gas Interests – When a Decade Makes a Difference

B. Suppes; IIMA, Johnstown, PA

Appraisals of oil and gas interests for estates can result in multiple appraisals for the same property. In the early stages of the Marcellus Shale play, a county in Pennsylvania which previously had little oil and gas activity, suddenly had major oil company well permits. Consequently, an appraisal was needed for an estate. Ten years later, the drilling permit had long expired, but the estate was still open. Another appraisal was needed. This paper discusses the what happens when appraised values decrease and estates are not closed timely.

3:05 pm

Pitfalls to Avoid When Selecting Production Data to Value Oil and Gas Properties

J. Hickman; Hickman Consulting Services, LLC, Canonsburg, PA

A common step in the process of establishing the value of an oil and gas property is to determine its ability to produce by reviewing the available production data from the surrounding oil and gas wells. As with any comparable, valuers and appraisers must take into account the year the wells to be used started producing and the completeness of the data set to ensure that the data is appropriate for the effective date of the report. In addition to this, oil and gas production data must be similar to the development that was probable for the property on the effective date. This means that questions of technology, reservoir continuance, practices common to the potentially developing company, and inherent issues with publicly available data should be considered. This talk reviews these lesser-known factors in detail from the perspective of an oil and gas exploration geologist and gives examples of the effect of ignoring them on the value of the property.

3:25 pm

Standards and Practices of Oil and Natural Gas Mineral Appraisals – The Guidelines to Reference and The Primary Variables to Evaluate

J. Partlow; Partlow Geological, Tuscaloosa, AL

Multiple international professional organizations involved in the oil and natural gas industry partnered to create the Petroleum Resources Management System (PRMS). This was created to set the foundation for evaluation procedures, reporting guidelines, and resource classifications. However, given the great variability in property value and different ownership types, there are different guideline requirements for different scenarios. The variation in property value and ownership characteristics will determine if a basic valuation is suitable or if a full appraisal is necessary. This presentation will identify the important variables regarding property ownership and lease information, petroleum geology and engineering, production forecasting, market inputs, and appraisal methods.