TECHNICAL PROGRAM

2022 SME Minnesota Conference

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Technical Program Abstracts

Tuesday, April 12, 2022

PROCESSING

Sponsored by Weir Minerals

Session Chair: Jon Maki, Cleveland Cliffs Inc.

1:00 PM
BALLROOM 1

1:00 PM
Benefits of Optimization of Mill Circuit Equipment

Debra Switzer; Weir Minerals North America, Houghton, Michigan, United States

Utilization of high efficiency equipment as well as ensuring that the mill circuit equipment is operating in ideal conditions can allow for realization of many benefits such as additional circuit capacity, increased recovery and reduced maintenance costs. In this presentation, we will look at potential areas that can provide opportunity for improvement as well as real world examples, one of which provided payback of the investment in less than one week.

1:30 PM
Managing Continuous Improvement of Mine to Mill begins with Measurement

Kevin Moran; Hexagon, Golden, Colorado, United States, Jeff Lobe; Hexagon, Vancouver, British Columbia, Canada, Peter Cameron; Hexagon, Hendra, Queensland, Australia, Rangan Ramanathan; Hexagon, Perth, WA 6000, Western Australia, Australia, Harrison Ingham; Hexagon, Denver, Colorado, United States

Core to continuous improvement is the need to understand the baseline and impact of changes to the process. In this paper, we discuss some of the critical attributes in the Mine-to-Mill process, including their influence on productivity and cost, the need for direct measurement, and areas where they should be applied. Many initiatives can be considered to improve Mine-to-Mill processes. Mining operations are planned and executed based on designs and models to achieve the operation's objectives. However, there are many variables in the different parts of the value chain, such as blasting, material handling, crushing, and screening. Therefore, measurement of the key attributes establishes the baseline for Mine-to-Mill (or Pit to Plant) performance, which is necessary to understand the impact of any proposed improvements to the process design and execution and monitor the outcomes on an ongoing basis sustain the improvements that have been implemented.

2:00 PM
An Advanced Dynamic Simulation for Tumbling Mills Using Analytical Solutions

Weiguo Xie; University of Minnesota Duluth, Duluth, Minnesota, United States

Due to the demands for process control, dynamic simulations for tumbling mills have attracted more attention in recent years. In this research, an advanced dynamic simulation for tumbling mills has been developed using analytical solutions. It can be seen that the analytical method is more accurate since it does not require the input of a time step, on the contrary, the choice of a time step is most critical for traditional numerical methods and it leads to inevitable errors. Furthermore, the analytical method saves the computational time because the required iterative methods by numerical techniques are avoided.

2:30 PM
Break

3:00 PM
Application of Magnetic Separation and Reverse Anionic Flotation For Fine Particles of Iron With High Sulfur Content

Moustapha Kebe; University of Alaska Fairbanks, Fairbanks, Alaska, United States, Fahimet Dehghani; University of Alaska Fairbanks, Fairbanks, Alaska, United States

The sulfur content in iron ore causes technical problems in the process of sintering iron ore, and environmental problems with the tailing discharged. The major challenge in iron ore processing plant is handling the finer particles. The objectives of this research include the concentration of Band Narges Mine (<150 µm) as well as the reduction of the sulfur content to achieve a marketable product. First, the mineralogical characterization of iron ore was established, secondly the metallurgical experiments were conducted, including magnetic separation and froth flotation. To increase the iron grade and recovery and decrease the sulfur content, two separate process flowsheets were tested, three steps of magnetic separation with a magnetic field strength of 2000G and a five-stage successive reverse flotation followed by three stages of magnetic separation at 1000G.

3:30 PM
Case Studies for Fine / Ultra Fine Grinding in Iron Ore

Garland Davis; Metso Outotec, Sandy, Utah, United States, Graham Davey; Metso Outotec, York, Pennsylvania, United States

MetsoOutotec is the world leading supplier of stirred mills, with a complete portfolio for various applications and as well providing process islands turnkey solutions. The three Stirred mills Vertimill, HIGmill & SMD together has more installations than any other supplier combined. This presentation will focus on the MetsoOutotec technologies for stirred milling and as well present case studies where the technologies successfully is in operation. The case studies will focus on operations of several Vertimills for an Iron ore mine.

4:00 PM
Reducing CO2 Emissions in Tailings Handling by Optimizing Pumping Efficiency

Kruyswijk; Weir Minerals, Austin, Texas, United States, Jason Janisch; Jasper Engineering And Equipment Co, Hibbing, Minnesota, United States; Erik Vlot, Weir Minerals Netherlands BV, Venlo, Netherlands

Sustainable tailings management is finding the balance between water preservation, long term stability and CO2 emissions. In the trade off between water preservation and energy consumption the largest improvement is achieved in greenfield projects. Incremental improvements in pumping- and dewatering efficiency can reduce energy consumption, and therewith CO2 emissions, considerably.Upgrading existing centrifugal pump trains with more efficient and durable pumps has a positive effect on the consumed power and operational costs. This effect can be maximized when the tailings density can be improved without significant changes in the process flow or current installed equipment. This study demonstrates the effect of upgrading an old centrifugal pump train with an upgraded, new, more efficient pump train, or alternatively a piston diaphragm pump.

ENVIRONMENTAL – WATER

Sponsored by Road Machinery & Supplies. Co

Session Chair: Larry Kramka, Foth Infrastructure & Environment, LLC

1:00 PM
BALLROOM 2

1:00 PM
Chemical Precipitation Technology in Removing Sulfate at Low Concentrations

Mei Cai; University of Minnesota Duluth, Duluth, Minnesota, Natural Resources Research Institute, Hermantown, Minnesota, United States, Shashi Rao; Natural Resources Research Institute (NRRI), Coleraine, Minnesota, United States, George Hudak; Natural Resources Research Institute, Duluth, Minnesota, United States

Minnesota has set a sulfate standard of 10 mg/L to protect wild rice. The traditional membrane-based technologies such as reverse osmosis and nanofiltration typically generates waste brine solutions that are technically challenging and costly to manage. NRRI has developed a cost-effective barite precipitation technology to remove sulfate. The dissolved sulfate readily precipitates with barium salts as insoluble barium sulfate (barite). The field pilot trials were performed in two municipal wastewater treatment plants at a flow rate of 1-2 gallon/minute in June-October 2021. During pilot trials, sulfate concentrations were successfully reduced from 60-115 mg/L to below 10 mg/L. This study highlights the potential of barite precipitation technology for achieving low concentrations (<10 mg/L) of sulfate.

1:30 PM
Modeling of Potential Impacts to Wetlands during Mine Development – Looking Beyond Drawdowns

Vikas Tandon, Mike Nimmer, and John Wozniewicz; Foth Infrastructure & Environment, LLC; St. Paul, Minnesota, United States

Mine operators and regulatory agencies are often required to predict and document potential impacts to wetlands associated with dewatering during open pit and underground mine operations. A common approach utilized is to predict drawdowns in groundwater caused by dewatering and establish a not to exceed threshold for drawdowns. This is then followed by implementing a monitoring program during the mine operations stage. Modeling at a planned mine in upper mid-west indicates that there are other criteria besides drawdown may serve as complimentary indicators of mine dewatering impacts. These criteria include projected and measured changes in 1) groundwater flux to wetlands, and 2) the recharge/discharge relationship between wetlands and surrounding groundwater. In this presentation, an approach to model and use these complimentary criteria to map the projected wetland areas that may be subject to impacts from mine dewatering will be shared.

2:00 PM
Water Quality from Potential Duluth Complex Analogue Operations: What Insights can be Gleaned for Minnesota?

Kathryn Vall; MineraLogic LLC, Duluth, Minnesota, United States, Tamara Diedrich; MineraLogic LLC, Duluth, Minnesota, United States, Kristin Riker-Coleman; MineraLogic LLC, Duluth, Minnesota, United States, Allison Haus; MineraLogic LLC, Duluth, Minnesota, United States

While Cu-Ni-PGE mining represents a new opportunity for Minnesota, mines of a related deposit style are well established in locations around the world, which provides an opportunity to gain insights from other operations. We have assembled a database of operational water quality data from active and closed mines around the world that are hosted in rocks comparable to the Duluth Complex. We have used statistical techniques and geochemical modeling to identify trends indicative of fundamental geochemical processes, focusing on water interacting with waste rock stockpiles and tailings basins. We will discuss implications for potential Duluth Complex mines.

2:30 PM
Break

3:00 PM
Sulfate and Trace Metal Precipitation

Travis Hanson; Kurita, Superior, Wisconsin, United States

The Saltout process is a sulfate removal method that meets variable effluent standards, including trace metals capture into a coproduct matrix suitable for landfill. This process is a valuable tool that will prevent future Acid Mine Drainage, improve recycled processing water quality, and meet tightening environmental standards. US Water has developed a high density sludge process to precipitate sulfates, metals, and encapsulate into an inert filter cake which is highly resistant to leaching. We will chronicle the pilot work and the removal rates of a variety of species; such as arsenic, mercury, selenium, copper, nickel, chrome, and barium.

3:30 PM
Select Aspects of the Bedrock Hydrogeology at The Proposed Twin Metals Minnesota Project

John Wozniewicz; Foth Infrastructure & Environment, LLC, Madison, Wisconsin, United States, Vikas Tandon; Foth Infrastructure & Environment, LLC, Lake Elmo, Minnesota, United States, Allison Haus; Foth Infrastructure & Environment, LLC, De Pere, Wisconsin, United States, Justin Brown; Foth Infrastructure & Environment, LLC, Duluth, Minnesota, United States

The proposed Twin Metals Minnesota project targets minerals in one area of the Duluth Complex called the Maturi Deposit in northeast Minnesota. A bedrock groundwater characterization program has been performed with a robust data set. Flow logging was conducted in 35 boreholes that covers 19 miles of borehole length to identify the location and hydraulic properties for discrete water conductive features.

Majority of the logged interval (86 %) contain a low hydraulic conductivity of < 10—11 m/s and <1% of the logged interval contain discrete features with moderate transmissivity values of 10-6 to 10-5 m2/s based on small volume tests. The water conductive features decrease in occurrence with depth and were evaluated for correlations with lithology, geologic contacts and structures. Transient analysis was performed on packer test data that encompasses select water conductive features to characterize their extent away from the boreholes.

4:00 PM
Risk Assessment of Aquifer Contamination in The Gala, Tenguel and Seven River Basins of the Ponce Enríquez Mining District

Paulo Andrés Campoverde Muñoz; Escuela Superior Politécnica del Litoral (ESPOL), Cuenca, Ecuador, AZUAY, Ecuador

This project evaluated the risk of contamination of the aquifers in the basins of the rivers: Gala, Tenguel and Siete; considering as a hypothesis that all mining activities conducted in the area, generate a high risk of contamination to aquifers. With this scenario, it was necessary to identify the condition of the aquifers, to implement practical actions to protect them from contamination. To do this, through the use of geographic information systems, two methodologies were used; a) DRASTC methodology; and b) the POSH hazard index based on potential sources of contamination. The evaluation of the risk of contamination of aquifers revealed that 20% of the study area corresponded to a High contamination index; Of this figure, 87% comes from agricultural activities, 9% from mining activities, and 5% from shrimp farms and urban areas. The project reveals important aspects about the contamination of aquifers, which is directly influenced by vulnerability.

MAINTENANCE & SAFETY

Sponsored by Burns & McDonnell

Session Chair: Jake Crispo, Northeast Technical Services, Inc.

1:00 PM
BALLROOM 3

1:00 PM
SEM-EDS: Advanced Wear Debris Analysis for Optimized Maintenance

Jeff Walkup; Fluid Life, Parker, Colorado, United States, Craig Winterfield; Fluid Life, Edmonton, Alberta, Canada

Large particle analysis is a critical, yet often neglected, element of most oil analysis and condition monitoring programs. Particles >10um are effectively invisible to a spectrometry-based oil analysis program. These large particles (>10um) provide critical information about machine health, component wear and contamination and are often considered an early warning of abnormal wear, bearing fatigue and transmission failure. With the use of Scanning Electron Microscopy – Energy Dispersive Spectroscopy (SEM-EDS) analysis, you can receive a clearer and more actionable picture of the possible sources and specific types of contamination and wear. SEM-EDS analysis can determine the size and composition of hundreds of particles per sample in lubricating oil, grease, filters, and process materials. In this presentation we will discuss how this technology can improve wear debris monitoring and help prevent equipment failures, minimize downtime, and reduce costs.

1:30 PM
Compressor Operational Efficiency Improvements at a Sulphuric Acid Plant by Enhancing Inlet Guide Vane Positioning

Mark Ferra; REXA Inc., Phoenix, Arizona, United States

At a nickel mine in Canada, oxygen gas is a critical feed requirement in the process to make sulfuric acid. Accurate positioning of the compressor inlet guide vanes (IGV's) is necessary to precisely control the gas throughput of the compressor. In 2016, two compressor IGV's were upgraded with six REXA Electraulic linear actuators. Plant personnel immediately noticed improved accuracy, repeatable to 0.1% of span regardless of process conditions. Due to the compressibility of air, the compressor turndown increased to safely operate and improve compressor efficiency. The plant's annual energy savings is USD$1,092,000.

2:00 PM
Reducing Energy Consumption, Increasing Wear Resistance, And Maximizing Outputs Through the Production of Crusher Wear Parts Made with New Alloys or a Combination of Traditional Alloys and Ceramic Materials

Gabrielle Hemond; AMCAST, Bohemia, New York, United States, Tomaso Veneroso, AMCAST, Bohemia, New York, United States

Mining uses a fraction of the amount of land that the agricultural industries use, and it's part of the renewable solution as well; however, mining consumes 2 to 3% of the world's electricity for comminution alone, demonstrating one of the many compelling reasons why comminution must be more energy efficient. Material science applied in wear parts manufacturing can reduce energy consumption in the crushing and grinding operations themselves. Wear parts can be manufactured solely using new alloys, or through a combination of new alloys and ceramic materials. Wear parts derived from material science-based inventions can preserve original as casted dimensions and angles during the entire wear mechanism. A crusher with a dimensionally consistent crushing chamber will increase productivity and reduce energy consumption by allowing a better flow of material and optimal crushing dynamics. This presentation describes the advantages of using non-traditional alloys to produce wear parts used in comminution.

2:30 PM
Break

3:00 PM
Economical, Low-Profile Capacitive Load Cells for Underground Mining Tool Wear Estimation and Material Classification to Promote Worker Safety

Austin Oltmanns; Colorado School of Mines, Golden, Colorado, United States, Andrew Petruska; Colorado School of Mines, Golden, Colorado, United States

A capacitive load cell, made to instrument conical picks in underground mining, is proposed to allow remote process feedback collection and further remove operators from hazardous zones near the continuous miner. The sensor is made using commercially available flexible printed circuit board technology and demonstrates in-situ sensing of continuous mining vibration signatures. A Support Vector Machine is used to classify the signatures into different wear categories and material types. The sensors are used in full scale rock cutting tests. Changes in capacitance due to strain from applied force are measured and differences in vibrational modes can be detected and classified.

3:30 PM
Fatigue-Managing the Unseen Threat

Mark Dowsett, Caterpillar, Inc., Redmond, Oregon, United States

How much is fatigue costing in lost production, inefficiency, maintenance, repairs, and the risk of serious injuries or fatalities? According to the National Sleep Foundation, US adults are sleeping only 6 hours 40 minutes per night during the work week. How much is enough? The science shows we need an average of 8 hours sleep per night for optimal alertness & productivity output. Are you getting enough? This DETECTION presentation will outline ways to see, mitigate and manage fatigue-related risks using technologies to fill the gap in pursuit of an empowering safety culture proposition: Safely Home. Everyone. Every Day.

4:00 PM
How Continuous Monitoring Can Increase Mine Safety

Andrew Munson; Frontier Precision, Arvada, Colorado, United States

Mine safety has always been a large consideration for daily operations. Maintaining a safe work environment can be difficult when inspections and data collection needs to be done manually, working in the areas of concern. Today, newer technology is able to assist us in collecting this useful data, often more accurately and consistently than if you were sending people into the mine. This technology is continuous monitoring equipment and can be used in many ways. Automated total stations and GNSS equipment can be installed to monitor a variety of things. Whether that be high-walls, dangerous slopes, tailings piles, tailings dam integrity, or any on-site structural movement. This equipment will work remotely, removing the need for a surveyor to be on-site. The associated software allows you to setup customized, automated alerts to any excess movement that is observed. Geospatial data can be supplemented with geotechnical sensors measuring many different things as well. Tilt-meters, piezometers, pressure sensors, weather stations, crack sensors, inclinometers and many more sensors can all be included within the same software platform, giving you a complete overview of any changing conditions on-site. The use of these technologies can greatly increase mine safety by knowing what is happening, 24/7

EXPLORATION UPDATES

1:00 PM
BALLROOM 4

Session Chair: Maggie Durenberger, Oreval

1:00 PM – 4:30 PM
Hear from companies discussing recent exploration activities in Minnesota.

Talon Metals – Updates presented by Jessica Johnson

North Star Minnesota Manganese Project – Updates presented by Rick Sandri

Vermillion Gold – Updates presented by Kate Lehmann

Wednesday, April 13, 2022

PROCESSING

Sponsored by Burns & McDonnell

Session Chair: Jeff Kiel, U.S. Steel

8:00 AM
BALLROOM 1

8:00 AM
A Summary of Recent Results of Hydrometallurgical Processing of an Oxide-Bearing Critical Mineral Deposit in Northeastern Minnesota

George Hudak; Natural Resources Research Institute, Duluth, Minnesota, United States, Jonathan Chen; Process Research Ortech, Mississauga, Ontario, Canada, V. I. Lakshmanan; Process Research Ortech, Mississauga, Ontario, Canada, Shashi Rao; Natural Resources Research Institute (NRRI), Coleraine, Minnesota, United States, Ram Sridhar; Process Research Ortech, Mississauga, Ontario, Canada and Matt Mlinar; UMD NRRI, Coleraine, Minnesota, United States

Over the past several years, the Natural Resources Research Institute and Process Research Ortech have collaborated on several mineral processing/hydrometallurgical studies to develop a hydrometallurgical process flowsheet to produce high-purity iron, titanium, and vanadium bearing products from a Minnesota critical metals-bearing oxide ultramafic intrusion. These studies include a batch pilot- scale study and a continuous pilot-scale study to produce high purity iron- and titanium-bearing products, as well as a subsequent bench scale study to evaluate value addition of high-purity vanadium-bearing products from process raffinates. Processing strategies and product characterization results will be summarized and discussed.

8:30 AM
Steps to Green Ironmaking

Kenneth Reid; University of Minnesota, Eden Prairie, Minnesota, United States

Over 90% of global metal production is steel, the backbone of modern civilization, and all steel starts in an iron ore mine. To remove oxygen from iron ore, a reductant and heat are required. However, the tradition reductant has been carbon, supplied by charcoal, coal, coke, oil or natural gas, and all discharge carbon dioxide, the dominant greenhouse gas. The reduction of greenhouse gases to avoid further global warming is a critical global issue. The evolution of ironmaking and historic improvements in carbon-based technology are discussed and steps toward carbon-free-hydrogen reduction outlined and discussed.

9:00 AM
Exsolve Recycling Technologies: Re-domesticating Wealth and Opportunity through Recapture of Lost Value Metals

Rob Bergmann; Exsolve, Minneapolis, Minnesota, United States

For decades the waste recovery model in North America has bled untold billions of dollars in value to overseas competitors like China, where as much as 75% of North American value metals are being processed and resold back to North American markets at a premium. Exsolve exists to recapture that lost value and re-domesticate critical mineral resources. Our mission is to pioneer metal recycling technologies to capture unrealized value from industrial metal waste. We believe that Minerals are the Future® and we see ourselves as the future of sustainable mineral development that can power a green economic boom in North America. We'll do it by recapturing resources and turning a loss leader into a major profit center. In this talk, Exsolve president Rob Bergmann will discuss how Exsolve is helping to build the green metal supply chain of the future!

9:30 AM
Break

10:00 AM
Iron of the Future Program

Rodney Johnson; University of Minnesota Duluth, Duluth, Minnesota, United States

These are exciting times to be involved in the iron industry. There are many challenges, some old, and many new. These challenges include societies expectation that the iron industry will reduce CO2 emissions, the transition away from blast furnaces to electric arc furnaces, changing ore quality, increasing energy costs, changing environmental regulations, and competition for high quality iron resources. There is increasing pressure to quickly address these challenges. NRRI is engaged in a long-term program to contribute to the health of Minnesota's iron-based industry. The program began with a Legislative appropriation through the LCCMR, the Western Mesabi Iron Resources of the Future project (2019). NRRI has since added the LCCMR funded New Iron Products (2020), and the DOE funded – Enhanced Pellet Chemistry project (2021). The program will develop new processing technologies and alternative higher values iron-based products. The Iron of the Future program is guided by the necessity to reduce the use of fossil fuels with the goal to achieve carbon neutral iron production in Minnesota, as well as reduce the use of process water and develop the technologies to reduce Hg in Minnesota's air and SO4 in Minnesota's water.

10:30 AM
Western Mesabi Iron Resources of the Future – Geometallurgical and Metallurgical Data Report

Rodney Johnson; University of Minnesota Duluth, Duluth, Minnesota, United States, Matt Mlinar; UMD NRRI, Coleraine, Minnesota, United States, Brett Spigarelli, University of Minnesota Duluth - NRRI, Coleraine, Minnesota, United States, Marsha Patelke; Precambrian Research Center, Duluth, Minnesota, United States

The Western Mesabi Iron Resources of the Future project is a multi-year study funded in 2019 by a Legislative appropriation through LCCMR. The project was designed to provide a comprehensive characterization of the Biwabik Iron Formation along the Western Mesabi Iron Range. The comprehensive characterization includes geology, chemical analysis, mineralogy, mineral chemistry, and conventional iron ore beneficiation processing (low-intensity magnetic separation and silica flotation). The information acquired during this program will be used to identify potential new uses for iron formation that is currently treated as waste; and to identify alternative beneficiation processes for improving the economic recovery of iron resources both for iron and steel production as well as developing alternative higher value iron-based products. An overview of the comprehensive characterization process, chemical, mineralogic, geometallurgical, and metallurgical results will be presented. The data collected may be used by mining companies to evaluate mining and product development opportunities and by government agencies to better understand environmental issues and approaches related to mining the iron formation.

11:00 AM

Enhanced Iron Ore Pellet Chemistry – Project Overview and Update

Brett Spigarelli; University of Minnesota Duluth - NRRI, COLERAINE, Minnesota, United States, Rodney Johnson; University of Minnesota Duluth, Duluth, Minnesota, United States, Basak Anameric; UMD NRRI CMRL, Coleraine, Minnesota, United States, Shashi Rao; University of Minnesota-Natural Resources Research Institute, Coleraine, Minnesota, United States, Kevin Kangas; Natural Resources Research Institute, Coleraine, Minnesota, United States

The Natural Resources Research Institute has been awarded a $2.1 million grant from the U.S. Department of Energy, Energy Efficiency and Renewable Energy, Advanced Manufacturing Office to explore enhanced iron ore pellet chemistry. The project will focus on the modification of ore-based feed materials to enhance gas- based direct reduced iron (DRI), the use of current and future ore materials from Minnesota and Michigan, and the creation of granulated iron products that will enhance EAF productivity and quality so that future steel manufacturing and energy efficiency are improved. The technology will include using appropriate fluxing agents to enhance the high temperature properties of the ore-based feed materials that can be employed by the gas-based DRI process using NRRI's new pilot-scale DRI simulator, and then subsequent post-treatment of the enhanced DRI in an auxiliary smelting vessel to produce iron nodules or pig iron for direct charging to the EAF. The combination of technologies will provide the necessary virgin metallic iron to meet EAF metallurgical requirements and improve overall steelmaking system efficiencies while maintaining a strong iron ore production industry in the USA

ENVIRONMENTAL

Sponsored by Road Machinery & Supplies Co.

Session Chair: Erin Budrow, SEH Inc.

8:00 AM
BALLROOM 2

8:00 AM

Direct Air Capture (DAC) and Carbon Mineralization

Todd Malan; Talon Metals, Jonas Lee; Carbon Capture

- A decarbonization pathway and a major new business opportunity for the mining industryLearn more about the project to capture CO2 directly from the atmosphere and store it in a nickel mine in Minnesota
- Understand the business case for storing CO2
- Learn about the current state of technology for both DAC and carbon mineralization

8:30 AM

Carbon Management Technology Assessment in the Mining Industry

Nicole Nguyen; Barr Engineering Co., Ann Arbor, Michigan, United States, Nick Sosalla; Barr Engineering Co., Hibbing, Minnesota, United States

We will explore the mining industry journey of carbon management through planning, concept development, and budget and risk assessments. We will discuss how services like greenhouse gas inventories, energy audits, and waste mass and energy balances can help provide data for prioritizing goals in managing carbon.We will also walk through how technology options are evaluated hollistically in order to provide the maximum benefit with the smallest capital or maintenance cost. Some of the technologies we will review include developing value-added carbon byproducts, carbon capture, and adding renewables on brownfield sites.

9:00 AM

Reducing Carbon Emissions and Sustainability in Surface Mining

Nicholas Voelz; Komatsu Mining Corp. Group, Milwaukee, Wisconsin, Unites States, David Guardamino; Komatsu Mining Corp. Group, Milwaukee, Wisconsin, Michael Fleet; Komatsu Mining Corp. Group, Longview, Texas, Unites States

The surface loading team would present around the topic of quantifying loading tool sustainability and the reduction of carbon emissions. This would be a presentation around sustainability of various loading tools and methods to review/quantify the metrics of sustainability. Examples include how to analyze fuel consumption and its effects on sustainability and maximizing production in a sustainable manner with a loading tool fleet.

9:30 AM

Break

10:00 AM

Recent Environmental Case Law Relevant to the Midwest Mining Industry

Jeremy Greenhouse; The Environmental Law Group, Ltd., Mendota Heights, Minnesota, United States

Over the past year, state and federal courts have issued decisions on environmental issues that either directly or indirectly impact the Minnesota/Midwest mining industry. The decisions addressed issues including but not limited to water quality standards, air permitting, groundwater, variances, contested case hearings, and environmental review. This presentation features a summary of the key recent cases and discusses the possible ramifications for the industry.

10:30 AM

ESG and Material Environmental Issues for the Mining Industry

Andy Polzin; Barr Engineering Co, Minneapolis, Minnesota, United States

The mining industry is facing unprecedented pressure to address ESG risks and opportunities and furnish performance metrics to stakeholders. Correctly identifying "material" issues helps avoid wasting resources and time pursuing environmental risks and opportunities that don't support your ESG strategy or improve your ESG performance in the eyes of your stakeholders. Material environmental issues are often obvious for a specific industry. For the mining industry, greenhouse gas and water use/disposal are typical. However, depending on the location, many other environmental issues may be material e.g. land use, species diversity, and habitat. This presentation will explore various methods of identifying material environmental issues and understanding the various ESG frameworks and reporting schemes.

11:00 AM

Bridging the Gap Between Industry and the Community: Managing Community Engagement

Angie Wagner; Trinity Consultants, Oakdale, Minnesota, United States, Tony Colomabri; Trinity Consultants, Oakdale, Minnesota, United States

Good community engagement is common sense, but it's not always easy to determine how to approach it to ensure success. With the Biden administration investing more money in environmental justice and other environmental initiatives, and increased interest by community members in industrial activities near their residences, schools, and workplaces, it is more important than ever to be thoughtful of the community located around industry and how to engage them at the right time. In this presentation we share initial actions/where to start with community engagement as well as engagement tips for success.

TAILINGS

Session Chair: Nathan Hofland, U.S. Steel

8:00 AM
BALLROOM 3

8:00 AM
The Impact of Stress History on Undrained Shear Strength of Clays in Northern Minnesota

Kurt Schimpke; Barr Engineering Co., Minneapolis, Minnesota, United States

Many tailings storage facilities (TSFs) in northern Minnesota are underlain by glacial deposits, including over-consolidated clay. It is common for designers to utilize an undrained shear strength ratio for clays to account for strength gain due to increased confinement resulting from ongoing dam construction and tailings deposition. The rate of strength gain is dependent on the stress history of the material. When loaded beyond the pre-consolidation pressure, clays become normally consolidated and their behavior changes. Failure to appreciate and appropriately capture this mechanism may lead to designs that are unconservative, potentially impacting dam stability. The stress history and normalized soil engineering property (SHANSEP) approach can be used to inter-relate changes in stress history and undrained shear strength. The presentation will discuss application of the SHANSEP approach for several clay types in northern Minnesota and provide recommendations for analysis and design.

8:30 AM
Tailings Surface Stacking; Two-Decade Report Card

Jerold Johnson; WesTech Engineering, LLC, Salt Lake City, Utah, United States

Facing challenges with tailings management, plants focus on storage capacity, stability, and water conservation. The TSF management plan, surface staking, has been used for over 20 years worldwide. This paper introduces the necessary technology components in the production of the non-Newtonian underflow, transportation, and TSF design and management. Longevity of the technology is demonstrated in three active sites: 1) Iron site in Inner Mongolia – 12 years; 2) Iron site in Republic of South Africa – 15 years; 3) Bauxite site in Brazil – 15 years. Each site illustrates the benefit of proper design, layout, equipment sizing, and operation of the surface stack.

9:00 AM
Engineering Considerations for the Proposed Twin Metals Minnesota Dry Stack Facility

Charlie Knilans; Twin Metals Minnesota, Ely, Minnesota, Unites States

The TMM Project evaluated multiple tailings storage facility options to pair with underground backfill for tailings management and selected to propose a dry stack facility. The dry stack facility requires filtering the tailings to remove free moisture prior to placing and compacting the tailings on a lined facility resulting in a reduced footprint and higher water recycle rate than a conventional tailings facility. The presentation will review key testwork and engineering considerations for the TMM's proposed dry stack facility. These considerations range from design of the tailings dewatering plant to produce the tailings filter cake to geotechnical considerations and water management strategies at the dry stack facility.

9:30 AM
Break

10:00 AM
Good-Better-Best Challenging Perception of Tailings Management Technologies

Pierre Mainville; Barr Engineering Co., Val Caron, Ontario, Canada

Tailing technologies are often viewed and ranked through a lens of Good-Better-Best, with dry-stack filtered tailings being perceived as a cure-all best available technology. The ranking of technologies in this way may be misleading, causing rework and delays. Each facility is unique, with site-specific constraints and opportunities that must be considered. This presentation will address this perception and discuss alternatives which better align with selecting the best tailings management strategy for each project.

10:30 AM
Water Quality Opportunity from Co-management of Taconite and Duluth Complex Tailings

Tamara Diedrich; MineraLogic LLC, Duluth, Minnesota, United States, Joel Bandstra; MineraLogic LLC, Hollidaysburg, Pennsylvania, United States, Stephen Day; SRK Consulting (Canada) Inc., Vancouver, British Columbia, Canada

Beneficial reuse of byproducts from both the established taconite and developing Cu-Ni mining industries represent a current opportunity for mine waste management in Northeastern Minnesota. A test program was conducted to demonstrate the effect of geochemical interactions occurring between tailings from the Duluth Complex and Biwabik Iron Formation. Results of this work indicate that drainage from weathering of Duluth Complex tailings reacts with taconite tailings to raise the pH of the resulting drainage and, decrease concentrations of select metals. The magnitude this decrease has grown over the 13 years of testing—a feature attributed to the unique characteristics of taconite tailings.

11:00 AM
Defining Waters of the United States. Again?!

Daniel DeJoode; SWCA, Savage, Minnesota, United States

The definition of Waters of the US (WOTUS) has undergone significant revision since it was introduced in the 1972 Clean Water Act. In recent years, several regulatory changes have occurred through rulemaking, executive order, and litigation to expand, contract, and again expand the extent of regulated WOTUS, which includes wetlands. Executive and judicial actions in 2021 have significant implications for how waters and wetlands are regulated. This presentation will provide an update on the ongoing rulemaking process, anticipated changes to the definition of WOTUS related to tributaries, ditches, wetlands, and exclusions, and implications for the mining industry.

MINING

Sponsored by Sandvik

Session Chair: Kathryn Larson, Minnesota Department of Natural Resources

8:00 AM
BALLROOM 4

8:00 AM
Off Base – Prospectivity of the Interior Duluth Complex

Gabriel Sweet; Big Rock Exploration, Minneapolis, Minnesota, United States

The basal Cu-Ni-PGE mineralization of the Duluth Complex (DC) has been a focus of exploration and development in the Midwest for nearly 75 years. Over 3.5 million feet of core has been drilled and numerous field programs executed in the advancement of Cu-Ni-PGE projects. Most of this work has been conducted within close proximity to the exposed basal mineralized zone (BMZ), leaving the remainder of the DC underexplored. However, recent exploration has documented occurrences of mineralization within the interior of the DC, emphasizing mineralizing system prospectivity outboard of the traditionally targeted BMZ. This presentation will discuss findings of modern exploration within the DC interior, noting some of the author's observations and the broad models into which they may fit. The presence of mineralization outboard of the BMZ suggests that potential exists in the interior DC, and that successful exploration and targeting of new mineralizing systems will require a creative approach.

8:30 AM
Digital Microscopy in Exploration Geology Through Implementation of the PiAutoStage System

Alex Steiner; Big Rock Exploration, Minneapolis, Minnesota, United States, Tyrone Rooney; Michigan State University, East Lansing, Michigan, United States

The development of the modern exploration environment has resulted in the application of sophisticated data- driven tools to probe mineralized systems, often through long-distance collaborative partnerships between multiple stakeholders and specialists. These tools require the critical geologic context provided by petrography. However, the collaborative interpretation of petrographic information is complicated by the non- digital nature of geologic thin sections. Here we describe the adaption and application of a new interactive digital microscopy system (PiAutoStage) to exploration environment workflows. We show that high-quality microscopy can now be accessed remotely, facilitating collaborative interactions and providing added value to existing data collection campaigns

9:00 AM
Creation of Geologic Domains for TMM's Geometallurgy Program

Nicole Hoffmann; Twin Metals Minnesota, Ely, Minnesota, United States, Kevin Boerst; Twin Metals Minnesota, Ely, Minnesota, United States, Steve Williams; Blue Coast Research, Parksville, British Columbia, Canada, Nichola McKay; Blue Coast Research, Parksville, British Columbia, Canada

The first step of any geometallurgy program is to define the geologic domains. For Twin Metals Minnesota's Maturi deposit, ~300 samples were characterized using: lithogeochemistry, QEMSCAN modal mineralogy, geologic core logs, structure data, and rock and mineral textures. Each characteristic was mapped, domained, and overlain in an attempt to understand both the geologic variability of Maturi and the variability found in metallurgic performance of the ore.

9:30 AM
Break

10:00 AM
How to Design, Implement, and Sustain an MOS - Management Operating System (Mining Ops / Maintenance)

David Truchot; Veltiosis Consulting LLC, Bayport, Minnesota, United States

Management Operating Systems are not well understood, and this course aims to share our expertise and some of the key tools to start identifying gaps that slow your organization' successes and launch sustainable correction action plans. We will review with you best practices that are in use at the bottom of pits or in maintenance workshops and share some of this insider knowledge so you can start optimizing your operations. We will provide you with a critical approach and a proven suite of tools that are used 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. The course materials are based on years of analysis, design and sustainable implementation of robust Management Operating Systems at various production facilities or maintenance organizations across the world.

10:30 AM
Innovation in Mine Material Classification and Segregation

Tom Meuzelaar; Life Cycle Geo, LLC., Longmont, Colorado, United States, Morgan Warren; Life Cycle Geo, LLC., Longmont, Colorado, United States, Alice Alex; Life Cycle Geo, LLC., Longmont, Colorado, United States

Advanced numerical algorithms (i.e., machine learning) combined with assay data can be used to more efficiently segregate mine materials by their geo-metallurgical and environmental properties, resulting in cost savings for mine operators and increasing efficiencies in permitting, mine planning and operational segregation. The general workflow consists of two general steps: 1) identify material types (classify) and 2) extend the classification to the site-wide assay database (proxy or surrogate analysis) for mine planning. These techniques are especially useful for sites where identifying material types is challenging, where certain material types are in short supply, where complex ore assemblages exist, or where an overly conservative permitting approach has limited operatory flexibility. This approach has further benefit in that it takes advantage of data that operators are generally already collecting (multi-element assay).

11:00 AM
Optimal Pitwall Shapes to Maximize Financial Return and Decrease Carbon Footprint of Open Pit Mines

Stefano Utili; Newcastle University, OptimalSlope Ltd, London, West Yorkshire, United Kingdom, Andrea Agosti; Newcastle University, Newcastle upon Tyne, West Yorkshire, United Kingdom

OptimalSlope determines geotechnically optimal depth varying slope shapes for the design of each slope sector of an open pit mine. OptimalSlope seeks the solution of a mathematical optimisation problem where the overall steepness of the pitwall (slope), from crest to toe, is maximised for an assigned stratigraphy, rock properties and Factor of Safety (FoS). The optimal profiles are always steeper than their planar counterparts (i.e. planar profiles exhibiting the same FoS). Adoption of overall steeper profiles allows a significant reduction of waste rock and, consequently, carbon footprint and energy consumption whilst improving mine profitability.

Calculations on three mine case studies will be presented showcasing the financial and environmental gains obtained by OptimalSlope.