ORAL PRESENTATIONS

DAY ONE – WEDNESDAY 01 OCTOBER

SESSION ONE: MINERAL RESOURCE ESTIMATION / NEW APPROACHES

Keynote: Advanced resource modelling through rapid user-supervised automated workflows

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Advanced resource modelling holds immense potential for improving mining operations and decisions by providing reliable models that capture the best local estimates, as well as resource variability, including the relationships between diverse variables of relevance. However, the complexity of advanced geostatistical techniques often makes it difficult for many people to use, as these techniques and data analyses are theoretically intricate and require experience to set up the many parameters needed.

This presentation will demonstrate how rapid user-supervised automated workflows can simplify this process. Current technology is available to deploy workflows that automatically assemble a resource model defining all the necessary steps and inferring the relevant modelling parameters, to provide a first approximation of the final resource model in a very short time. This initial automated implementation can then be customized through user-supervised analysis and parameter tunning, to enhance the inference and lead to a model satisfactory for public disclosure and reporting under a qualified person's criteria.

The use of advanced computing to reduce the processing time during the model's computation and the integration of intuitive user interfaces and implementation, can empower regular users to access advanced geostatistical modelling tools for estimation, risk assessment and sensitivity analysis. A preliminary model can be assembled in just seconds, including alternative realizations to get an understanding of the uncertainty, which can be translated into risk. Finally, a simple iteration over the different parameters can give a quantification of sensitivity, to identify the weaknesses and strengths of the model.

Some of the fundamental challenges in resource modelling include capturing and representing trends accurately, capturing the complex multivariate relationships inherent in geometallurgy and assessing risk through the construction of multivariate geostatistical simulations. All these challenges are simplified with rapid user-supervised automated workflows. By addressing these modelling challenges through automation, we can unlock the true value of advanced geostatistical modelling for a broader audience.

Machine Learning models for uncertainty quantification of mineral resource estimates

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Mineral resource estimates are the outcome of a multi-stage process requiring several dozens of parameters and split across teams of multiple disciplines such as field technicians, laboratories and resource geologists. The effects and final impact on the models of these parameters are not often apprehended nor quantified. Designs of Experiments (DoE) allow us to analyse the sensitivity and the uncertainty of the model linked to the parameters value using an automated workflow and a specific plan of experiments in order to avoid unrealistic computation time. Uncertainty analysis relies on Surface Response Design in order to reduce the required computation time compared to traditional full factorial or grid search approaches. The response surface is a proxy of the complete mineral resource estimation, allowing fast computation. Coupled with the Monte Carlo scheme, it is possible to predict the uncertainty of the final estimates using different combinations of input parameters. The surface response is modeled using a second degree polynomial regression, which does not capture the nonlinear relationships between the parameters. Polynomial regression could be replaced by machine learning models, benefiting from their ability to model higher order relationships between the parameters to improve the proxy model. The presentation will be focused on the exploration of different machine learning algorithms in order to evaluate their ability to improve the results compared to a traditional second degree polynomial regression. The uncertainty analysis workflow will be performed on an open iron ore dataset from the Pilbara Craton in Western Australia.

What a Geologist Thinks They Are Giving a Mining Engineer, and What a Mining Engineer Thinks They Are Getting — Are They the Same Thing?

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The interface between resource geology and mine planning is a critical point in the value chain, yet it often suffers from miscommunication and mismatched expectations. This paper explores the disconnect between what resource geologists believe they are delivering in a resource model and what mine planners assume they are receiving. The paper examines how misunderstandings can lead to the misinterpretation and misuse of resource models; sometimes with significant consequences for project economics, risk management, and operational outcomes.

Key issues discussed include the interpretation and communication of recoverable resources, the impact of model classification on mine design decisions, and the role of spatial uncertainty and localisation and their use in strategic planning. The paper highlights the complexity and nuance of these estimation aspects can be lost on mining engineers. Also highlighted, will be some of the things that resource estimators should consider when building their models to ensure they are fit for purpose in planning and economic evaluation – things like modelling waste and dilution, incorporating necessary geometallurgical parameters and providing clear handover documentation.

To address these challenges, the paper advocates for greater cross-disciplinary dialogue and education. Ultimately, bridging this gap is essential for improving the reliability of resource-to-reserve conversions and unlocking latent value across the mining lifecycle.

A general methodology for defining modelling domains in geostatistical applications

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The construction of spatial models for resource estimation, geometallurgical modelling or uncertainty quantification (geostatistical simulation), require the definition of modelling domains, that is, volumes (or areas) where the variables are consistent, in order to avoid mixing data that behave differently during the subsequent analyses. These domains must be homogeneous from a statistical standpoint, as well as geologically, and spatially coherent. The selection of relevant samples for geostatistical modelling is constrained by the physical extent of 3D estimation domains. Defining an estimation domain is fundamentally a sample classification problem aimed at achieving homogeneity in statistical parameters, mineralisation direction, and variogram structure within each domain. In practice, geologists log different geological features such as alteration, mineralization and lithology, in drill cores before conducting multivariate trace element geochemical analyses and geometallurgical tests. These data sources have recently gained interest for defining estimation domains. This study presents a detailed methodology for selecting geochemical variables and key elemental ratios to enable feature extraction and unsupervised classification for modelling distinct zones in a porphyry copper deposit, that can be used as estimation domains. Various data transformation, feature extraction, and unsupervised classification techniques are applied and compared to delineate alteration zones at sampled locations. The results are interpreted using statistical tools (e.g., boxplots, histograms) to highlight distinctive traits and validated through a numerical comparison against visually logged alteration records. Additionally, the approach identifies key elements and ratios associated with alteration mineralogy, enhancing the geological interpretation of the porphyry copper system. The methodology is adaptable and broadly applicable to different case studies, integrating multiple data sources for domain modelling using a wide range of data transformation, feature extraction, and classification techniques.

Python-Powered Workflows in Mining: From Automation to Innovation

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1DeepLime

Python has become an essential tool for geoscientists over the past decade. Its scripting capabilities, combined with its rich ecosystem of scientific and graphical libraries, enable efficient exploration of large datasets, versatile computations, and automation, from simple scripts to complex AI-driven models. From data mining to full modeling workflows, Python accelerates work and fosters innovation at multiple levels. This presentation will highlight the benefits of Python-based approaches in the mining industry, particularly for mineral resource evaluation. Through real-world examples, we will showcase applications ranging from generic tools, such as drillhole data validation, to fully customized workflows. We will present two case studies from Western Australia. The first will demonstrate how to automate an entire mineral resource estimation workflow, from data cleaning to integrating natural constraints, enabling real-time model updates as new data becomes available. The second will focus on the use of machine learning for predicting alumina recovery from multiple analytical methods, improving efficiency and decision-making in processing operations. Beyond these examples, we will discuss the critical role of data and process standardization, as well as the challenges that remain in making these approaches more accessible. The use of Python proves to be a game-changer in the mining landscape as in many others in geoscience, enhancing efficiency, reducing errors, and empowering geoscientists with powerful, adaptable solutions tailored to industry needs.

Nickel grade estimation using the novel hybrid model of the artificial neural network (ANN) – Archimedes Optimization Algorithm (AOA)

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This study proposed a hybrid model to estimate the nickel grade in the Petasia Nickel Project, North Morowali, Central Sulawesi, Indonesia. The hybrid model employed the artificial neural network (ANN) which was optimized using the Archimedes Optimization Algorithm (AOA). This study involved 125 drill holes that were 99 holes used as the training data and 26 holes as test data. The estimation performance was tested using the root mean squared error (RMSE) and mean absolute error (MAE). The ordinary kriging (OK) and inverse distance squared (IDS) suggested the lowest RMSE of 0.50 and 0.50, respectively, and 0.40 and 0.44 of MAE. The RMSE of ANN and ANN-AOA were 1.67 and 0.87, while MAE were 0.83 and 0.55, respectively. Although, the RMSE and MAE of OK and IDS were lower than ANN-AOA, however, it demonstrated the closest mean value to the actual value. This revealed that the novel hybrid model could be applied to estimate the ore grade in the mining projects.

SESSION TWO: SAMPLING / QAQC

Keynote:From sample to data.... unmentioned sources of bias..... the case for Quality Management

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It's been a long journey since Professor Pierre Gy started developing the Theory of Sampling (TOS) in the 1950's. Since then, TOS has been deeply discussed and developed by recognized specialists such as Francis Pitard and Dominique François-Bongarçon, among others.

Throughout this development, both a whole mathematical and statistical analysis, as well as issues and sources of bias during TOS applications have been described and highlighted in different publications (impact of segregation, material heterogeneity, types of errors, etc.).

This keynote is focused on an emerging bias in the mining industry, which is not normally mentioned or considered, but has an important impact on current and future results. This issue is the knowledge or quantified representiveness of the samples/data used for business decisions.

"Bias 1": Strong focus on "data processing", assuming the data is "representative". This refers to the strong focus in the mining industry on how to use a "number" reported by a laboratory. There are significant investments in artificial intelligence, machine learning, conditional simulation and more sophisticated statistical analysis promising optimizations, but under the primary (potentially false) assumption that the data used is representative.

"Bias 2": False sense of confidence based on theoretical concepts that don't consider, or omit, all the potential sources of bias that can happen during the implementation of a designed sampling protocol. This includes sampling processes following a structured and/or a studied protocol but lacking routine inspections (field, core sheds and/or laboratory) to monitor the tools, conditions and deviations from the designed protocol used in practical implementation. For example, inhouse sampling devices, scoops, cups, coffee cups, hands, etc. as sources of bias and/or increased variability.

"Bias 3": Isolated or siloed view of the process from sampling to the final assay/data reported. This refers to the management disconnection between sample collection, preparation and analysis that needs to be treated holistically: investments in getting quicker assay results, for example, mean less if gaps during sample collection are impacting the representiveness of the samples arriving at the lab or new technologies.

With all these sources of potential "bias" in the current "in vogue" methods and procedures in the industry, Quality Management is becoming a key practice to proactively monitor/quantify the representiveness of the samples and data, under a continuous improvement philosophy, tracking gaps and following up solutions on a "holistic perspective" over issues on sample collection, preparation and analysis.

Presenting the international sampling standard DS 3077:2024

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Since the turn of the Millenium the Theory of Sampling (TOS) has been developed in an introductory axiomatic system, recently published as DS3077: 2024 “Representative Sampling – Horisontal Standard (3. ed)”. This framework has served many scientific and technological communities well by presenting a professional overview of all necessary-and-sufficient concepts and principles, sampling errors and practical sampling unit operations, ready to use, guaranteeimg representativity under all conditions. DS3077 is the foundation for all sampling, quality control, quality assurance and MRE.

Application of PhotonAssay™ to Coarse-Gold Mineralisation – The Importance of Rig to Assay Optimisation

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Sample collection, preparation and assaying are a vital activity at all stages of a mining project. Field sample collection is followed by sample reduction in both mass and fragment size to provide a sub-sample for assay. This process can be particularly challenging in the precious metal environment and may require specifically designed protocols. One of the biggest challenges is ensuring that all sampling and sub-sampling errors are controlled across the entire rig to assay pathway. In most cases, the primary sampling error (the error at the rig and/or core shed) may swamp the entire process. Challenges also exist throughout all sampling stages when coarse gold is present. In particular, the pulp is likely to contain some liberated, poorly comminuted gold particles, requiring the pulp to be assayed in total to avoid unnecessary additional errors during splitting and handling. PhotonAssay™ is a non-destructive and rapid gold assay technique capable of analysing coarse crushed (<3 mm) 350-500 g samples at a rate of ~70 samples per hour. It displays fast assay turn-around-times, requires lower staffing levels to operate, and removes the need for chemicals such as lead or cyanide. These characteristics make it applicable to gold ores, particularly those bearing coarse gold, as only crushing is required (minimal liberated gold) and multiple lots can be assayed. However, this advantage will be reduced if any of the sampling stages are not optimised. The optimisation of a sampling protocol comes from understanding the mineralisation and desired programme outputs. It is not simply a mathematical, or a statistical process, but a complex process taking advantage of orebody knowledge (including gold deportment studies) and application of the Theory of Sampling.

The Importance of QAQC in Mineral Resource Estimation.

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Quality assurance and quality control (QAQC) is a fundamental part of reliable sampling and analytical programmes. QAQC programmes enable an understanding of the accuracy and precision of data used in mineral resource estimation and are required when using reporting codes. Such programmes inform confidence in data and can reduce risk and improve methodology of sampling and analysis. The accuracy and precision of any sampling programme are typically monitored by the insertion of; certified reference material (CRM) or standards, blank samples; and duplicate samples. Establishing protocols, providing training. documenting procedures, auditing and regular analysis of QC samples help to mitigate against sample bias and achieve an acceptable level of repeatability. QAQC programmes should be adjusted as the project progresses from early-stage exploration through to resource estimation and grade control. The fundamental, and proven principles in undertaking and executing QAQC programmes largely remain unchanged. As computer and software packages have developed, it is now quicker and easier to implement and review the data. Despite this, the results are often not reviewed in detail and updates to sampling and analytical procedures not always prioritised, which can reduce confidence in the data. This presentation/paper aims to look at the different types of QC samples and analysis of the results, highlighting typical errors which are often overlooked. Using case studies, it is highlighted how QAQC assists the resource geologist in understanding the data used for the mineral resource estimate.

DAY ONE – THURSDAY 02 OCTOBER

SESSION THREE: MINERAL RESOURCE ESTIMATION CASE STUDIES

Keynote: Smart Modelling: AI and Machine Learning in Geometallurgy's Digital Transformation

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Digitalization in the age of data abundance is rapidly redefining the evolution of the mining industry. As ore bodies become more variable and operations face increasing demands for sustainability and efficiency, traditional approaches to resource modelling and mine planning are no longer sufficient. This talk explores how geometallurgical integration, powered by artificial intelligence (AI), machine learning, and data fusion, can help transform resource models into intelligent, process-aware systems.

By combining geological, mineralogical, metallurgical, and operational data, digital tools now enable geometallurgical models that not only reflect geological complexity but also anticipate processing behavior. These AI-driven models support real-time planning, adaptive scheduling, and improved metallurgical forecasting. Yet, critical challenges remain, such as aligning and validating data from diverse sources, capturing uncertainty, and ensuring that models remain relevant as operational conditions change.

This talk addresses both the static understanding of ore-process relationships and the dynamic engineering of adaptive geometallurgical models. It will present current strategies for deploying machine learning algorithms and robotic data acquisition within mine-to-mill workflows, and how these technologies can enhance resource reporting, mine planning, and process plant optimization.

By embedding AI into geometallurgical modelling, resource models become more than static outputs. They evolve into living systems continuously learning, adapting, and guiding smarter decisions across the entire mine life cycle.

Towards a geo-met model of the Beauvoir Granite - the continued development of a European hard rock lithium project

Owen Herod[1] *Benjamin Barre*[1]*; Patrick Fullenwarth*[1]

1Imerys

Imerys' EMILI (Exploitation de MIca Lithinifère par Imerys) project is evaluating the lithium and other metal potential of their Beauvoir kaolin operation in central France. The project completed a Pre-Feasibility Study (PFS) in early 2025 supporting continued investment in this European lithium deposit. The significant geology, modelling and estimation work that contributed to the PFS is presented here with a focus on mineralogical modelling. The Beauvoir Granite is a highly evolved, Variscan leuco-granite intruded as part of the Échassières complex in the north-east margin of the French Massif Central. The granite predominantly comprises quartz, albite and lepidolite with an extensive list of minor minerals. Post intrusion greisen alteration has locally impacted lithium grades whereas late-stage kaolinisation has little impact. Detailed resource investigation started in 2021 with over 90 drillholes and 33,000 meters of core completed. Over 60 elements were routinely measured. Quality Control samples, at both coarse and pulp, have been routine since the beginning and have driven improvements in sub-sampling practices. The 2024 MRE estimated 10 elements and mineralogical factors using a combination of approaches. The proposed concentration plant uses flotation to separate lepidolite (mica) from quartz and feldspar. In areas of intense greisen alteration hydrothermal muscovite is also present; muscovite is poorly differentiated in flotation and reduces the Li2O content of the final concentrate. Two mineralogical indexes were initially developed combining Si, Na, K, Ca and P which were able to complement geological logging in identifying areas of intense greisen alteration. In 2024, to further the understanding of the deposit mineralogy, 18,000 meters of core was hyperspectrally scanned. Detailed mineral mapping of 47 samples using an SEM was used to calibrate the hyperspectral interpretation. These data are planned to be modelled for future studies.

The Importance of Proven Material in Industrial Mineral Ore Reserves. A Case Study of the Epanko Graphite Project, Tanzania

David Drabble[1] *Andrew Spinks*[1]*, David Williams*[2] *and Samir Khamoud*[3]

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Several of the minerals featured on critical minerals lists published by Australia, the European Commission and the United States of America happen to be what the JORC Code regards as Industrial Minerals. Industrial Minerals are those whose variable physical specification dictates its potential uses and thus its value. With graphite, much of the value lies with its flake size, which helps establish its suitability for different applications, for example, as a refractory (large flake) or battery anode (fine flake) material. The importance of physical specifications in Industrial Minerals can determine whether a deposit is economically viable, hence the requirement to consider these, along with other Modifying Factors whilst classifying an Ore Reserve. Given the reliance on an Ore Reserve when determining the economics of a Project, the authors of this paper consider that, for Industrial Minerals a minimum portion of Reserves must be Proven and such defined within the JORC Code. This would help prevent companies which hold Industrial Mineral deposits, with unfavourable physical specifications for the minerals, from misleading investors into the viability of a project. This becomes of greater significance when considering the elevated level of importance that Modifying Factors are anticipated to have in the forthcoming update to the JORC Code. This paper takes the Epanko Graphite Project in Tanzania as a case study, where 82 % of its total Ore Reserve is classified as Proven, partially dictated by the strong understanding of the metallurgy, physical properties and marketability of the ore and product, which has been established over the past 12 years. Analysis was completed on 19 major, publicly listed graphite deposits, of which 15 had declared a Reserve. Results of which demonstrate significant variation amongst peers, with five of the 15 containing 0 % Proven.

Challenges of Mineral Resource Estimation in High-Nugget Coarse Gold-Bearing Conglomerates: Case Study from the Beatons Creek Deposit, Pilbara, WA

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Gold is present within the matrix of multiple/narrow stacked conglomerate horizons, which are interbedded with un-mineralised sediments. It occurs as free particles within the conglomerate matrix. Challenges in the estimation of the Mineral Resource (MRE) and grade control (GC) models related to the presence of coarse gold; a high nugget effect; narrow widths (0.5-2 m); and complex internal geology. Mining start-up challenges related to the complexity of the mineralisation; positive bias of channel samples and their effect on the MRE; and delays in GC assays. As a result, the first mining panels were extracted using the MRE model. The cessation of mining related to the depletion of oxide mineralisation; poor economics due to lower gold grades; higher operating costs; and delayed fresh mineralisation approvals. Several sampling techniques had been applied across the project including diamond and RC drilling, and channel and bulk sampling. The 2018 bulk sampling programme verified likely mineable grades across the conglomerate width. RC drilling was the dominant method across the 2019-2023 models. A 0.5 m sample was collected which still lead to dilution of the true mineralisation thickness spanning the true thickness boundaries. Gold determination methods included screen/fire assay and LeachWELL. The final 2023 MRE was based on dominantly PhotonAssay (90% overall). The final 2023 MRE included a number of key changes: addition of 1,540 RC drillholes (for 9,457 samples many at 10 by 10 m spacing); exclusion of channel samples; revised geological interpretation; changes to faults that cut/bound the conglomerates; and updated oxide-fresh surfaces. The paper will discuss the estimation challenges across the MRE and GC models, and the key learnings as the project developed.

3D Estimation of a Narrow Copper Vein in Poland: Addressing the Limitations of Traditional Grade-Thickness Approaches

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In resource estimation, narrow vein systems present unique challenges, particularly when traditional 2D grade-thickness (GT) methods fail to capture the complex internal geometry and grade variability within the vein. These approaches also lack the spatial resolution required for stope optimization and do not allow for testing of multiple dilution scenarios. At the ***** (getting client consent to name project) concession in western Poland, a copper-bearing vein hosted within Kupferschiefer sandstone was modelled using a full 3D approach in Leapfrog, diverging from the conventional GT method. This strategy was chosen to better represent the vein's spatial continuity and grade variability within the vein height, providing a more geologically meaningful foundation for estimation. The project's database compilation involved meticulous reconciliation of modern and historical drilling datasets, with varying assay detail and survey quality. A domain was built to define the ore zone above a 0.05% Cu cut-off, using composited intervals and stratigraphic coordinate transformations based on a paleotopographic surface. Several flattening methods (onlap, truncation, proportional) were tested, with “onlap” selected as the most suitable for maintaining variogram continuity within the ore zone. The 3D block model was subsequently back-transformed into real space to enable volume reporting and integration with techno-economic evaluations. This case study illustrates the limitations of traditional 2D estimation techniques for narrow, discontinuous mineralisation and proposes a flexible 3D workflow tailored to constrained geometries and sparse datasets. In addition to capturing the structural complexity of the deposit, the 3D model supports testing of variable dilution scenarios and dynamic cut-off grades in response to changing price assumptions—features not feasible in a GT-based approach.

Fit the Model to the Data, not the Data to the Model: A Case Study from the Sabodala-Massawa Gold Tenement, Senegal

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1Endeavor Mining

The Sabodala-Massawa Gold Tenement is located in southeast Senegal and hosts Endeavour Mining's Sabodala-Massawa Gold Operation (SMGO). Commercial production started in 2009 and has produced over 3.8 Moz Au to date. It currently has a total endowment of over 9.2 Moz Au, including a Measured and Indicated Resource of 5.4 Moz Au (as of 31 December 2024). The tenement lies on the western side of the Palaeo-Proterzoic Kedougou-Kenieba Inlier which hosts the Sabodala-Sofia Shear Zone (SSZ) and the Main Transcurrent Shear Zone (MTZ) regional structures. The Sabodala-Massawa tenement is composed of three mining licences covering 611 km2 and five current exploration licences covering 540 km2. The tenement database hosts approximately 120 current and historical anomalies, targets, deposits and Mineral Resources - a huge number in an area 85 km long and typically 25 km wide. It currently has 19 deposits with current Mineral Resource Estimates (MRE) (reported following CIM Definition Standards), six historical MREs which no longer have reasonable prospects for economic extraction (RPEE), and eight mined out/exhausted deposits. Five different mineralisation styles have been identified to date in the SSZ and MTZ and each style contains variations on the theme. Hence, it is important to operate and manage exploration programmes, resource delineation drilling and Mineral Estimates with an open mind and not use a single one-size-fits-all approach and to fit the model to the data, not the data to the model! This paper will illustrate the five types and show some examples of why the data should determine the interpretation and model, and not the other way round!

SESSION FOUR: MINERAL RESOURCE REPORTING

Keynote: JORC 2025 and the evolution of reporting Codes – implications for the industry

Ian Glacken[1]

1Snowden Optiro

Most of the world's mine production is regulated in equity markets and by a series of reporting Codes, most of which align with the CRIRSCO standard. Because of the nature of the initiation of these Codes around the world, updates happen irregularly and sequentially. The last major Code upgrades were the PERC Code and the S-K 1300 regulations, in 2021 and 2022. Arguably the two most used Codes (by number of market listings) are the CIM Guidelines in Canada and the JORC Code in Australia, these were last updated in 2014 and 2012 respectively.

In Australia the JORC Code is nearing the end of a long, involved and somewhat fragmented update process, and a 2025 version will be released this year (2025) following extensive consultation and rework following the 2024 Exposure Draft. As a participant in the process, it is instructive to detail the interplay of the various stakeholders (not just the equity markets), the trends across the global mining industry over the past 12 to 13 years, and the changes in emphasis in parts of the Code, most notably the role of the Competent Person(s) and the increased emphasis on Environmental, Social and Governmental issues; also new aspects to the Code, such as the introduction of production reconciliation. The evolution of the JORC Code from 2012 to 2025 and its relationship to stakeholders has important implications for the next major international update (the CIM Guidelines) and for future iterations of the PERC Code and others.

Does ESG belong in mineral resource reporting?

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1SRK
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The concept of environment, social and governance (or 'ESG') is frequently used interchangeably with 'sustainability'. When considering reasonable prospects, these terms are often interpreted differently by individuals and organisations across a range of jurisdictions, contexts and political affiliations. Therefore the understanding of how ESG can or should influence mineral resource declarations is also vastly different. Recent efforts by international mineral reporting codes to prompt for improved disclosure of ESG information has been met with polarized responses. Whilst many appreciate the rationale for these inclusions there are others who question the relevance of ESG in mineral resource reporting or conflate this with sustainability reporting and perceptions around greenwashing. As with other aspects of mineral reporting, mainstream media, social media and political views of the day may (correctly or incorrectly) be influencing these opinions (think deposit vs resource vs reserve). This presentation will seek to unpack the authors' perspective on the reasons for these polarized views and explore past failures arising from ignoring ESG factors early on in mineral project development. Reference will be made to recent consultations undertaken to support the update of JORC and NI43-101, as well as the recently released CRIRSCO ESG Definitions Guide and the ESG guidelines issued by SAMCODES and CIM. As a contribution to improving future practices, the presentation will conclude by proposing a pragmatic approach to ESG integration into mineral resource reporting. This approach is contained in the CRIRSCO ESG Definitions Guide which was published in late 2024 and to which the authors contributed.

Responsible Mining - A Balanced Approach to Mineral Resource Reporting.

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Until recently, most 'reasonable prospects for eventual economic extraction' (RPEEE) assessments for Mineral Resource Estimates (MRE's) were largely driven based on mining techno-economic assessments, with considerations around environment, social and governance (ESG) typically limited to cautionary wording, deferring commentary and investigation to future Project stages. However, increased expectations from evolving mineral reporting codes, increased pressure from investors and government, and demands from other stakeholders for the mining industry to contribute to the energy transition in a responsible manner, exploration projects are now under pressure to demonstrate their commitment to integrating ESG considerations into project decision making. This talk, through case study presentation, demonstrates an exploration project review methodology where there is positive commitment to embedding responsible practice at an early stage. In this example, ESG considerations were assessed with equal rigour alongside the more routinely considered technical and economic counterparts to determine whether RPEEE could be positively supported for future Mineral Resource reporting.

Classification – are we suffering from groupthink

Mark Burnett

AMC

POSTER PRESENTATIONS

The Genesis and Styles of Akobo Gold Mineralization within the Shear Zone ultramafic belt in southwestern Ethiopia.

Siraj Beyan Mohamed*[1]*, *Tarekegn Tadesse*[1] *Dekssisa Debele*[1] *Daniel Meshesha*[1]

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The Genesis and Styles of Akobo Gold Mineralization refers to the intricate geological and mineralization processes that characterize gold deposits within the Surma Shear Zone ultramafic belt in southwestern Ethiopia. This region, particularly the Segele gold deposit, is notable for its complex geological history marked by tectonic evolution, hydrothermal alterations, and diverse mineralization styles, which have drawn significant interest for exploration and mining activities in recent years. The gold deposits are primarily classified as Orogenic Gold Deposits, formed in association with extensive tectonic activities that led to the formation of distinct mineral assemblages within ultramafic host rocks . A key aspect of the Akobo mineralization is the unique interplay of geological, hydrothermal, and tectonic processes that govern gold deposition. Hydrothermal fluids rich in gold are believed to be transported in solution and precipitated under varying physicochemical conditions, which include temperature, pressure, and fluid composition changes . The presence of arsenopyrite and other sulfide minerals plays a critical role in the concentration and deposition of gold, facilitating the development of significant ore deposits in the region . Various styles of gold mineralization have been identified within the Akobo region, including fault-hosted quartz-vein systems, orogenic deposits, and Carlin-type mineralization. Due to local structural controls and alteration processes, each style displays unique geological and hydrothermal features. This diversity highlights the potential for future discoveries and resource development in the region while also reflecting the complexity of mineralization in the Surma Shear Zone. Additionally, the relationship between the styles of gold mineralization between the Gindibaba and Joru gold deposits, which are located approximately 11 kilometers apart, and the Segele ultramafic rocks, which contain very high grade gold and are hosted within the quartz veins of different generations within the Quartzfeldespathic schists unit, presents promising economic opportunities for future work. The genesis of the gold bearing fluid, which is more likely to be a magmatic fluid, is also unclear. . The balance between resource extraction and environmental stewardship remains a critical consideration for mining operations in this ecologically sensitive region, prompting ongoing discussions about responsible mining practices and community engagement . As exploration continues, the Akobo region stands out as a focal point for both geological research and economic development in Ethiopia.

Advancing Mine Tailings Characterization: A Hybrid Geostatistical–Deep Learning Approach

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Effective management of mine tailings has become a pivotal challenge for modern mining, not only to mitigate environmental impacts but also to harness untapped secondary resources in line with circular economy objectives. Traditional geostatistical methods such as ordinary kriging (OK) can approximate spatial distributions of valuable and hazardous elements; however, they often fail to capture the inherent heterogeneity and localized anomalies found in historical tailings deposits. In this work, we present a novel hybrid Geostatistical Convolutional Neural Network–Recurrent Neural Network (GCNN–RNN) framework designed to enhance geochemical prediction accuracy. First, variogram modeling and OK are used to quantify and incorporate spatial covariances. Next, these geostatistical features are merged with a 1D CNN–BiLSTM deep learning model that learns complex nonlinear patterns in the data. Applied to a tailings site, the approach consistently decrease prediction errors relative to conventional kriging, especially in regions of sparse data and high concentration variability. The proposed framework provides high-resolution, spatially informed predictions of both critical raw materials and potential contaminants. The outcomes enable better-targeted remediation strategies to manage environmental risks, while simultaneously identifying areas rich in recoverable metals. This dual benefit underscores the role of advanced machine learning in sustainable resource recovery and in safeguarding ecosystems. Ultimately, our GCNN–RNN approach demonstrates a powerful synergy between geostatistics and deep learning, offering a template for broader applications in tailings re-mining, mineral exploration, and responsible stewardship of mined landscapes.

High-resolution imaging spectroscopy as a tool for drill core mineral mapping

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Imaging spectroscopy is a powerful analytical technique that enables the identification and mapping of geological material through infrared wavelengths, capturing mineral-specific spectral fingerprints. While widely applied at airborne and outcrop scales in mining, its use at sub-millimetre (~150 µm) resolution remains underexplored [1,2]. This approach may bridge the gap between discrete sample analyses and core-scale observations, generating a continuous record that provides unprecedented insights into alteration processes beyond traditional core description. Demonstrating the effectiveness and value of imaging spectroscopy at this scale requires careful integration with more traditional approaches (e.g. core description, thin sections, mineral and bulk rock geochemical analyses) to understand how it can be leveraged to improve our geological interpretations. Our study will apply the novel microimaging technique to drill core samples from modern mid-ocean ridge and the Oman ophiolite, to assess the distribution, timing and magnitude of hydrothermal alteration in the ocean crust [3], whilst assessing the advantages and limitations of high-resolution imaging spectroscopy as a tool in characterising fluid/rock reactions. The methodology also holds significant potential for the mining industry as a rapid, scalable, and non-destructive alternative to conventional techniques for identifying mineralisation patterns, such as alteration halos [4]. As mining operations seek to optimise resource assessment strategies, integrating imaging spectroscopy presents a promising advancement. 1 Greenberger, R. et al. Imaging spectroscopy of geological samples and outcrops: Novel insights from microns to meters. GSA Today 25, 4-10 (2015). https://doi.org/10.1130/GSATG252A.1 2 Greenberger, R. N. et al. Hydrothermal Alteration of the Ocean Crust and Patterns in Mineralization With Depth as Measured by Micro-Imaging Infrared Spectroscopy. Journal of Geophysical Research: Solid Earth 126, e2021JB021976 (2021). https://doi.org/https://doi.org/10.1029/2021JB021976 3 Harris, M. et al. Hydrothermal cooling of the ocean crust: Insights from ODP Hole 1256D. Earth and Planetary Science Letters 462, 110-121 (2017). https://doi.org/https://doi.org/10.1016/j.epsl.2017.01.010 4 Mathieu, L. Quantifying Hydrothermal Alteration: A Review of Methods. Geosciences (2018).

True Grit: characterising the complexity of silica sands

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Silica sand, a fundamental component in numerous industrial processes, can be characterised prior to extraction using geometallurgical techniques. This in turn allows optimisation of processing and resource utilisation. Billions of tonnes of silica sand are mined each year, and the increase in extraction rate shows no sign of abating. Understanding the complexity of seemingly-uniform silica sand deposits is a priority when defining which of the myriad uses of silica a deposit is suitable for. There are diverse sources of silica sand and the varying quality and content of deposits influences extraction techniques and refining processes. The presentation is based around the author's recent work on an African silica sand deposit Scoping Study, and how a detailed metallurgical testwork programme has allowed integration of different potential-product domains into the deposit model. This has allowed the owner to develop the value of their product, its place in the market, and to approach off-takers from a much stronger position. The discussion will delve into grain size distribution, mineralogical composition, and impurity profiles, and how these can be combined and transformed into predictive models that optimise silica sand extraction processes, ensuring sustainable resource use whilst meeting the evolving needs of industry.