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Technology developments and case studies in **Integrated Interpretation**: developing a single earth model quantitatively consistent with all data, driven by conceptual understanding.

Opening note

A vision for integrated interpretation

John McGaughey
President, Mira Geoscience

The role of interpretation is necessarily evolving as the mining industry addresses the challenge of finding and mining significant new deposits at depth, under cover, or in complex brownfields settings. In this modern context, exploration targeting will result more from recognition of ore system signatures in multi-disciplinary 3D model space, and less from recognition of anomalies in data. Successful interpretation in model space, not data space, implies that each data set play an integrated role in the construction of the multi-disciplinary earth models upon which targets are developed. A common sense approach is presented to overcoming both the technical and cultural challenges in achieving the required level of quantitative integration.

Methods and case studies in integrated interpretation

Integrated interpretation case study, Bayanhongor Province, Mongolia

Tim Chalke
Director, Asia-Pacific, Mira Geoscience

The role of geophysics and geochemistry is necessarily evolving as modern exploration addresses the challenge of finding significant new deposits at depth, under cover, or in complex brownfields settings. This exploration activity can be driven by a fundamental understanding of mineralisation processes and the associated ore system signatures. This is therefore a step away from recognising anomalies in 'data space' but rather an interpretation in model space where the data informs components of this ore system signature.

The interpretation of geophysical and geochemical data can therefore be focused on informing geological objectives of understanding. This is done through interpreting how this relates to ore system signatures. It integrates science, technology, and economics to produce a scientific basis from which further exploration can be undertaken on a Project with significantly greater confidence and efficiency, resulting in increased economic, social and environmental benefit. And, as that further Exploration advances, and the results continue to be aggregated, the original scientific basis of understanding becomes exponentially increased, as do the consequential beneficial results.

This method of analysis will be demonstrated with a project in Mongolia exploring for Porphyry Cu-Au.

Why stochastic modeling should be compulsory in resources modelisation?

Erwan Gloaguen
Professor, INRS-ETE

Building accurate 3D grade models is obviously important for maximizing the NPV of a mining project. In the mean time, grade models are most of the time build using only grades data measured at wells. If strong and complex spatial variability is present conventional modeling tools fails. Oil industry has a long history of integrating geophysical data not only for exploration, but also for reservoir modeling. However, in order to translate geophysical responses into grades proxy, one has to perform numerical inversion. In this presentation, I will show why least-squared inversion are generally not appropriate to guide grade modeling and i present one solution based on a real reservoir located in Québec.

Integrated interpretation: 3D geological models for petroleum and mineral exploration

Dianne Mitchinson
Senior Consultant, Mira Geoscience

A geophysically-constrained 3D geologic model of the Whitehorse Trough and bounding geologic units in Yukon Territory, Canada, was completed to improve understanding of the distribution of geologic units and structures under surficial cover and at depth in an area with potential for mineral and oil and gas resources. Physical property data were critical to constraining VPmg and UBC-GIF inversion models that refined the geometry of Whitehorse Trough sedimentary basins, and defined the shapes and depths of buried magnetic bodies interpreted as potentially prospective Jurassic age intrusions. Residuals between observed and predicted geophysical data highlight key areas of interest for more in-depth investigation of geology and physical properties.

Integrating geomechanics into contemporary mine designs

Luigi Cotesta
Principal Geomechanics Engineer, Itasca Consulting Canada Inc

It is well known that Geomechanics plays an essential role in mine design. Ultimately, final designs must be profitable, without sacrificing mine stability. While this seems intuitive, integrating this knowledge into mine designs is not straightforward. To help achieve this goal, Itasca have developed a Computer Integrated Geomechanical Mine Modelling Approach (CIGMMA). The methodology provides a means of identifying risks early within the project evaluation cycle; provides operators with enough lead time to implement risk management strategies well ahead of execution; and enables design teams to better forecast geomechanics-related costs, i.e. ground support etc. Examples will be shown that demonstrate how recent advances in software and hardware have helped to integrate geomechanics into the mine design process.

Estimating the existence probability of cavities using multi-geophysical data

Gyesoon Park
Senior Researcher, *KIGAM (Korea Institute of Geoscience and Mineral Resources)*

The Existence Probability(Ep) of cavities affecting ground stability was analyzed using borehole data, electrical resistivity and gravity data. A neural network training function was used to estimate the contribution coefficients of physical properties that play a part in determining the Ep. For this process, the resistivity and density values, where borehole data exist, were used as training data. And the target probability was constructed using borehole data. The pseudo-Ep was then calculated using the estimated contribution coefficients. The range of pseudo-Ep was adjusted for conversion into the Ep of cavities, and this new approach was verified by comparison with prior research and commensurate with prior results. The new probability approach is useful for not only detecting cavities but also imaging underground structures.

Towards a better understanding of the HudBay Lalor deposit through multi-disciplinary interpretation of the TGI4 3D seismic data

Peter Dueck
Chief Geophysicist, Hudbay Minerals

The Geological Survey of Canada (GSC), in conjunction with Hudbay Minerals, collected approximately 16km^2 of 3D-3C seismic data over the current Lalor mine as part of the TGI-4 geoscience initiative. When used along with the downhole geochemical data, geological cross-sections, and physical rock properties logged in critical holes, the dataset becomes unique and powerful when trying to link geology, geochemistry and geophysics into a single story validated by the three disciplines. This coordination of the three disciples in crucial to understand, not only the geological setting of the deposit, but how exploration moves forward and evolves in the future.

3D mineral prospectivity mapping of unconformity-type U deposits along the southeastern margin of the Athabasca Basin, Northern Saskatchewan, Canada

Leonardo Feltrin
Research Scientist, Western University

The Paleo-Mesoproterozoic Athabasca Basin in northern Saskatchewan, Canada, and the underlying deformed and metamorphosed Archean and Paleoproterozoic rocks host unconformity-type uranium deposits which are spatially associated with faults that cut the unconformity between the basin-fill sandstones and the underlying metamorphic basement rocks. This work is focused on the Millennium-McArthur River trend and the objective is to build a multilayer 3D model for the uranium ore system which integrates: (i) reconstructions of the tectono-stratigraphic architecture of the basin and its basement; (ii) expert-driven interpretations of basement/basin structures and their quantitative correlation to mineral deposits; and (iii) various geological, geophysical, geochemical, and petrophysical interpretations to define the footprint.

3D multi-disciplinary data integration for feasibility mining studies: An example from the Premier Gold Mines Hardrock project

Kenneth Williamson
Senior Geologist, Development Projects. Premier Gold Mines

Premier Gold Mines Hardrock project is located in the vicinity of the municipality of Geraldton, Ontario. It consists of an Open Pit mine project currently in a feasibility stage. Amongst many other tools, GoCAD is the preferred common platform where most of the data, coming from multiple sources, is being consolidated. Conditional querying of the model allows the identification of key areas where specific parameters are met. For example, RQD data from drill holes and location of historical mine openings can be transposed onto planar structures and pit walls, highlighting areas where ground stability could become an issue. ICP data combined with Au grade data allows for the identification of areas where potential gold recovery issues need to be addressed.

Software solutions for integrated interpretation

SKUA-GOCAD productivity enhancements

Aymen Haouesse
Product Manager, Paradigm®

In addition to the many advances in science and subsurface modeling workflows, SKUA-GOCAD has seen recently many developments to improve the productivity of geoscientists while performing their regular tasks. This presentation will focus on some of these productivity tools including Annotations and Reporting to capture critical data and process information, Macro commands to automate user workflows and perform sensitivity analysis and Result Analytics to capture and analyze the different decision oriented metrics and compare alternative scenarios.

Data management solutions

Valérie Laflèche
Senior Geological Engineer, Mira Geoscience

Deficiencies in data management have been identified as a major barrier to successful interpretation of the complex data relationships in many projects. Our solution to address this problem is Geoscience INTEGRATOR; the data management component of our three-platform offering. It allows storing, grouping and querying multi-disciplinary exploration and geotechnical data, models, files and documents, thus integrating project data in a single repository shared by all team members, for optimal analysis and decision making.

Geoscience INTEGRATOR is built to manage 4D data because time-based properties are paramount at the mine site for assessing geotechnical hazards for safety and production decisions.

Geoscience INTEGRATOR interfaces with visualization, modelling, query and expert system applications to drive exploration and mining success.

Linking Geoscience INTEGRATOR drillhole data with DRX drillhole optimization

Andrew Dasys
President, Objectivity.ca

The technologies that power the web are creating a significant opportunity to improve how mineral deposits are defined as well as how resources are quantified and brought to market.

Objectivity's DRX drill hole optimization software provides a browser based visualization and layout capability that communicates directly with Mira Geoscience's INTEGRATOR

This talk focuses on how Integrator and DRX can improve resource conversion rates for late stage resource definition by using algorithms for drillhole placement and selection while making all data available in a single central storage location.

Modelling software solutions

Gervais Perron
Director, Software Solutions, Mira Geoscience

GOCAD Mining Suite is the industry's only integrated modelling solution. It is designed on the premise that earth models with quantitatively consistent representations of geological, geophysical, geochemical, and geotechnical data, are fundamental to exploration and geotechnical decision making. We are in the process of transforming the GOCAD Mining Suite to the Paradigm SKUA-GOCAD 2014 platform, with many interface and modelling functionality improvements. The new, modernized product line will be released in mid-2015 as a base platform and three modules:

1. *Integrated Interpretation*: Creation of earth models quantitatively consistent with geological, geophysical, and geochemical data, suitable for exploration targeting.
2. *Advanced Geophysical Interpretation*: Advanced modelling and inversion of geophysical data within the earth modelling platform.
3. *Geotechnical Interpretation*: Advanced modelling and interpretation of geotechnical data.

Analysis software solutions

Gervais Perron
Director, Software Solutions, Mira Geoscience

Our analysis platform, “Geoscience ANALYST”, is complementary to the GOCAD Mining Suite modelling platform. GOCAD Mining Suite is for producers of earth models; Geoscience ANALYST is for consumers. Earth model consumers are the decision makers who require access to earth models created by technical modelling specialists to support exploration and geotechnical decision-making. Geoscience ANALYST is an integrated data and earth model viewer with an interface that is fundamentally business-domain focused. It specifically geared to mineral exploration and mine engineering managers. It will be used as a primary means of communicating earth modelling results and the exploration or geotechnical business decisions based on them. In addition to reading from local file-based data sources, it will also connect to the Geoscience INTEGRATOR data management system over local networks or the internet, acting as a 3D visual interface to the data management system.