Earth Modelling 2013 Abstracts and Presentations

Technology advancements and data integration forum

Vancouver, Canada, October 21-22

October 21 - Geomodelling: Concepts, applications and technology

A full-day session that will provide discussion of current technology developments in 3D earth modelling, feature case studies from industry practitioners, review ongoing software development, and give a sneak peek about what is around the corner.

Technical session: Geomodelling technology and developments

Geophysical joint inversion honouring geological constraints from 3D models

Peter Lelièvre
Research Associate, Memorial University

We are researching geophysical modelling methods that utilize unstructured meshes to help incorporate constraining geological information. Working with unstructured meshes ensures that geological features built in 3D modelling software (e.g. GOCAD) can be represented exactly in our geophysical inversion software. We are investigating exploration scenarios in which unstructured meshes might provide improved results over standard rectlinear meshes. We are also researching a new inversion approach that represents the Earth model as a set of connected wireframe surfaces, exactly as is commonly built via 3D modelling software. This contrasts to the common approach of discretizing the Earth into a volume of many small cells. With this new approach, statistical information regarding the uncertainty of model features can be readily calculated.

Mapping geophysically defined contacts

Bill Morris
Professor, McMaster University

Geophysical mapping in geology

Data management for effective earth modelling

John McGaughey
President, Mira Geoscience

Efficiently managing data for effective earth modelling is a universal challenge. Around the world, from mine sites to exploration offices, bringing multi-disciplinary geoscience data together into a coherent 3D interpretation has consistently proven to be a greater organizational than technical challenge. Over the last few years we have increasingly been drawn into providing data management solutions as a pre-requisite to effective earth modelling. Here we describe our approach, addressing the management of multiple live data sources to directly drive earth modelling business results, including real-time updates of time-dependent models.

Case studies: Geoscientists at work

3D geostatistical porosity modelling: A case study at St-Flavien CO2 storage project

Maxime Claprood
Research Associate, INRS-ETE

Geostatistical simulations are used to assess the porosity governed by geological facies in order to evaluate the CO2 injection scenarios in the St-Flavien gas field (Québec, Canada). The integration of 3D seismic data (seismic amplitude and acoustic impedance) with acoustic impedance and porosity well logs by a Bayesian simulation workflow allows generating several realizations of porosity of the St-Flavien gas field. A connectivity analysis between porous zones and non-shaly petrophysical families is computed for each realization, which permits to evaluate the CO2 storage potential of the St-Flavien gas field under geological uncertainty.

Earth Modelling 2013 Abstracts and Presentations

Technology advancements and data integration forum

Vancouver, Canada, October 21-22

Case studies: Geoscientists at work

Multi-disciplinary 3D models of the Slave and Rae cratons, central Canada

David Snyder
Geophysicist, Geological Survey of Canada

Increased seismic station coverage and intense diamond exploration activity during the past two decades has greatly increased the amount and density of geohysical and geochemical data relevant to understanding the deep structure of continental interiors, particularly the Slave and Rae cratons within the Canadian Shield. We are now able to compile diverse data sets that are inherently 1-D, 2-D or 3-D in nature into a single geo-registered 3-D model to 400-km depth that enables direct comparisons. Sparse, localized geochemical information can thus be extrapolated over large regions using remote geophysical observations to gain insights into the geological construction of the ltihosphere and its metasomatism and mineralization history.

Regional 3D GOCAD model of the eastern sub-Athabasca basement: Implications for new uranium discovery

Irvine R. Annesley
Independent Researcher / Adjunct Professor, University of Saskatchewan

In this study, a 3D geological model of the eastern sub-Athabasca basement of northern Saskatchewan (i.e. the eastern and western Wollaston Domain, the Wollaston-Mudjatik Transition Zone (WMTZ), and the Mudjatik Domain) was developed in the common earth GOCAD environment and constrained by topographic, geophysical potential field, outcrop, drill hole, petrophysical, and petrological data, along with high-resolution regional seismic lines, in order to better understand the regional- to district-scale tectonics and controls over the uranium mineral system(s) operating pre-, syn-, and post-Athabasca deposition. This knowledge is being used to identify key exploration vectoring criteria for unconformity-type, magmatic, and metamorphic/metasomatic uranium deposits and to delineate new exploration targets in the basin.

Structural geology for engineering: Snap Lake case study

Wayne Barnett
Principal Structural Geologist, SRK Consulting (Canada) Inc.

Structural geology is a critical input into geotechnical engineering. Structures strongly influence the behavior of the rock mass in mining environments and are critical hydro-geological controls on the groundwater movement into excavations. There is a general lack of best practice guidelines for geologists explaining what types of structural data should be collected and analyzed in order to effectively communicate to engineers what they need to know about structural geometries, their properties and the natural variability of those properties. Modern 3-D visualization tools can help with the communication process. A best-practice document is being completed as a guide to effective structural geologist-to-engineer communication.

Snap Lake underground diamond mine in NWT is an operation that is currently extracting a shallow dipping kimberlite dyke from below a lake. The kimberlite was influenced by pre-existing structures during emplacement and forms clay-breccias along intersections with some structures that are technically challenging and expensive to develop through. The same structures need to be modeled for geotechnical and hydrological studies. SRK undertook structural mapping, paleostress analysis and 3-D modeling of the structures at the mine. The 3-D model wireframes were imported into GoCad for clipping and further analysis. Proximity queries were used to associate rock properties with modeled structures. Properties were painted onto the fault surfaces and interpolated using GoCad's DSI algorithm, which effectively simulated some of the variability that could be expected on fault surfaces. The properties of each fault set are also presented graphically as an example of what data can be of use to the geotechnical engineers.

Earth Modelling 2013 Abstracts and Presentations

Technology advancements and data integration forum

Vancouver, Canada, October 21-22

Case studies: Geoscientists at work

Analysing and integrating geochemical data

Pim van Geffen
Senior Geochemist, ioGlobal Solutions Inc

Geochemical data are generally obtained for a vast range of elements. However, data for the majority of these elements are often underutilised in mineral exploration and lithogeochemical modelling. Geochemical data analysis can be used to identify patterns in data space that have strong implications in physical space, such as chemostratigraphy, rock classification and geochemical targeting. Whole-rock geochemistry allows for stoichiometric modelling of mineralogy, identification of rock types, and quantification of alteration intensity, providing spatial gradients that vector towards systems of mineralising potential.

Developer's sandbox: Software developments

3D modelling of geological surfaces using generalized interpolation with Radial Basis Functions

Michael Hillier
3D Modeller/GIS Specialist, Geological Survey of Canada

A generalized interpolation framework using radial basis functions (RBF) is presented that implicitly models 3D continuous geological surfaces from scattered multivariate data. Generalized interpolants can use multiple types of independent constraints. Common constraints such as on-contact, gradient, and tangent constraints are permitted. The general form of the mathematical framework allows us to further expand on solutions by including stratigraphic data from above and below targeted surfaces as inequality constraints. Multiple case studies are presented that demonstrates the advantages and general performance of the surface modelling method for mining applications.

Mira Geoscience's software development roadmap: A look at 2014 and beyond

Gervais Perron
Director Software Solutions, Mira Geoscience

Speed Geeking: Innovative developments

ioGAS Link to GOCAD Mining Suite: The power of 3D spatial queries

Geotech: Recognition of geohazard risk

3D parametric structural surface modelling in sparse data regional setting

Targeting Workflow: Comprehensive 3D mineral potential mapping environment

EM1D: Invertion for layered-earth (1D) models using time-domain airborne EM data

Exploration data analysis using 3D-GIS queries

Earth Modelling 2013 Abstracts and Presentations

Technology advancements and data integration forum

Vancouver, Canada, October 21-22

October 22 - Quantitative data integration symposium

This year's symposium will focus on target recognition in complex, multi-disciplinary 3D exploration models. The meeting will consider data management and the critical petrophysical link amongst exploration criteria, but primarily concentrate on target definition, recognition, and vectoring. The current state of knowledge-driven and data-driven approaches to discovery will be addressed by an international group of academic and industry practitioners from Canada, the U.S., Europe and Australia.

Presentations

Introduction - Quantitative data integration for targeting

John McGaughey
President, Mira Geoscience

Compilation of multiple data streams into an earth model with predictive capacity has obvious business value in resource exploration and exploitation. Much of that value rests on the recognition of "targets", which can be achieved using methods ranging from 3D visualization to computational pattern recognition. Both knowledge-driven and data-driven statistical approaches have proven themselves capable of identifying combinations of earth-model variables that can be interpreted in terms of exploration drillhole targets, geotechnical hazards, or mineral processing factors. The purpose of today's symposium is to provide an overview and discussion forum on techniques, best practices, and future directions in statistical recognition of patterns in earth models that provide direct business value as exploration vectors, geotechnical hazard evaluations, or process control inputs.

A new storage approach for 3D modelling

Paul Gabriel
CEO, GiGa infosystems GbR

GST – Geosciences in Space and Time – was designed to fit the needs of geologists and mining engineers while modeling. The archaic approach to store 3D geological models in files has reached its limitations. Thus many users can access the organized data simultaneously and use the software they are familiar with. Besides being able to convert between proprietary and open standard formats GST allows also to use different coordinate systems within one project by enabling automatic coordinate transformation. Because of storing the data in a database all the data can be connected with existing databases for primary data.

The challenges of mapping ground hazards routinely at PotashCorp

Craig Funk
Chief Geophysicist, PotashCorp

Data integration for 4D targeting of hazardous mining conditions.

Petrophysical domains: Quantitatively linking geology to geophysics

Vince Gerrie
President & Director R&D, DGI Geoscience

Classification statistics and machine learning applied to physical rock properties.

Earth Modelling 2013 Abstracts and Presentations

Technology advancements and data integration forum

Vancouver, Canada, October 21-22

Presentations

Mining oil sands: Improving productivity with data mining and predictive analytics

Paul Sheremeto
CEO, Pattern Discovery Technologies Inc

Oil sands in Western Canada represents approximately 97% of Canada's oil reserves. With so much at stake, it is imperative that oil sands operators find methods that will maximize bitumen production while minimizing the environmental impact of the process. These operators have turned to data mining and predictive analytics to unlock the mysteries associated with efficiently and effectively extracting the bitumen in the ore. The presentation will focus on how analytics is used to understand the factors contributing to the "processability" of the oil sands ore and how predictive models drive decisions on control room strategies for extractions.

A mathematical view of logistic regression and weights-of-evidence

Helmut Schaeben
Professor, TU Bergakademie Freiberg

Mathematical methods of potential modelling are considered from the point of view of generalized linear models and Markov stochastic graphs, where the notion of conditional independence is essential. Referring to log-linear models provides another test of conditional independence. Then weights-of-evidence, logistic regression without interaction terms, and logistic regression including interaction terms can be put into a hierarchy of methods, where each former method is a special case of the consecutive latter method. Logistic regression is less restrictive than weights-of-evidence, accounts for violation of conditional independence exactly by corresponding interaction terms, and is optimum for discrete, binary or categorical, predictor variables.

A statistical data mining study from the Eastern Goldfields of Western Australia

Colin Barnett
Principal and Co-Founder, BW Mining

The most critical decision in exploration is deciding where to look. This decision is often based on partial information rather than quantitative analysis of all the data. We need to put more effort into objective targeting in order to improve the discovery rate. The best way to do this, in sufficiently mature districts, is to use statistical data mining techniques, which take advantage of all the available data in a given area. The targets generated by this objective approach are highly focused, so that only limited budgets are needed for follow-up investigations.

To explain how statistical data mining works, a particular case study from the Eastern Goldfields of Western Australia will be presented, which serves to illustrate all aspects of the approach.

For more information, see www.bwmining.com

Mineral potential mapping: The GSC perspective

Jeff Harris
Research Scientist, Geological Survey of Canada

The developments of methods for producing predictive maps of mineral potential has had a long and rich history at the Geological Survey of Canada. This ranges from the initial developments of the weights-of-evidence (WoFE) method developed by Agterberg, Bonham-Carter and Wright to the new proximity-distance approach by Chung and Franklin. Many factors are important in the mineral potential modelling process including how training data can be used, data preparation of evidence maps, and modelling method, be it based on data- or knowledge-driven techniques. This presentation provides a summary of some the of the key issues learned over the last 25 years related to the GSC's developments in the mineral potential mapping process.

ASTER based exploration for prophyry style mineralization in the southern Gobi Desert, Mongolia: a Knowledge-Driven and Data-Driven Appraisal

Leonardo Feltrin
Research Scientist, University Western Ontario

Remote sensing and mineral exploration.