3D geological modelling for geo-environmental characterization of mineral deposits and pragmatic management of geochemical risks.

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Abstract

An understanding of geochemical risks associated with mineral deposits and how they can be managed often begins with an investigation of the conceptual environmental geological model. Previously this was generally based on geological cross-sections and analysis of drillcore logs. 3D geological modelling software has been widely used for mineral resource applications but its value for use investigating acid rock drainage risk of projects is still relatively limited. This poster outlines how 3D geological modelling software can be used on a wide range of mining projects to quantitatively manage geochemical risks associated with mine operation and closure. The 3D geological modelling software, Petrel (Schlumberger), although originally developed for oilfield settings, has since 2008 been applied in geo-environmental characterization, geochemical risk assessments and waste rock management planning for more than 100 new mining projects and operations globally. The principal applications for which the software has been used include the development of defensible sampling plans for static and kinetic testing, elucidation of the spatial and temporal variability of ARD/ML risks during operation and closure, and optimization of the scheduling and distribution of waste rock to backfill, reactive waste or 'inert' waste storage facilities. A particular strength of the 3D modelling approach is the ease with which ARD classifications may be visualized in conjunction with economic (commodity assay or rock value), geo-mechanical and other variables of relevance to the wider mine planning process.

Key words: ARD, Petrel, Geostatistics, 3D geological models

Introduction

Successful characterization of the environmental geology of mineral deposits, including the identification of representative sample populations for assessment of acid rock drainage (ARD) and metal leaching (ML) risks at the design stages of new mining projects, relies fundamentally on a capacity to visualize and classify in three dimensions the rock units present. Traditionally, this information has been obtained through geo-statistical analysis of drill core logs, or through the construction from such logs of cross-sections to depict the distribution of discrete lithology-alteration-mineralization (LAM) units within an area of proposed open pit or underground mine development.

While 3D geological modelling software has been used for more than a decade for interpolation of exploration drill hole information of relevance to mineral resource estimation, the adoption of such software within the realm of environmental geology has been suprisingly limited. The use of 3D modelling software allows, however, rapid integration, geostatistical analysis and visualization of multi-variable datasets (such as those relating to lithology, alteration and mineralization type) in a manner which substantially improves the confidence level with which representative sampling programs for industry-standard static and kinetic testing may be undertaken and for the practical incorporation of the results of such tests into activities such as mine design optimization and operational waste rock handling.

Software application

Software used for 3D modelling of mineral resources has previously been reported for use within ARD/ML studies (Linklater et. al. 2015). The 3D geological modelling software, Petrel (Schlumberger),

although originally developed for oilfield settings, has since 2008 been applied in geo-environmental characterization, geochemical risk assessments and waste rock management planning for more than 100 new mining projects and operations globally. The principal applications for which the software has been used include:

- Statistical interrogation of geological block models in conjunction with mine plans (for example, annual pit shells) to develop defensible sampling plans for static and kinetic testing.
- Incorporation of ARD/ML classification systems into geological block models, thus allowing the spatial and temporal variability of ARD/ML risks to be elucidated when interrogated in conjunction with mine plan information (for example annual pit shells as shown in Figure 1).
- Dynamic calculation of changes in the magnitude of ARD/ML risks during progressive inundation of open pit and underground mines at closure.
- Optimization of the scheduling and distribution of waste rock to backfill, reactive waste or 'inert' waste storage facilities through mine life, based on differential ARD/ML classifications.

In many instances, the incorporation of ARD/ML classifications into a 3D geological model can be performed on the basis of only one variable (for example sulphide S, see Figure 2). However, Petrel has also been applied for complex situations in which waste rock behaviour is a function of multiple variables. A particular strength of the 3D modelling approach is the ease with which ARD classifications may be visualized in conjunction with economic (commodity assay or rock value), geo-mechanical and other variables of relevance to the wider mine planning process. This effecivtively enables coupling of ARD/ML studies with resource models, pit design and mine scheduling tools. Ultimately, the benefit of this approach has been an improved awareness of the risks associated with ARD/ML throughout the life of mining projects, and an improved capacity to pro-actively avert or mitigate.

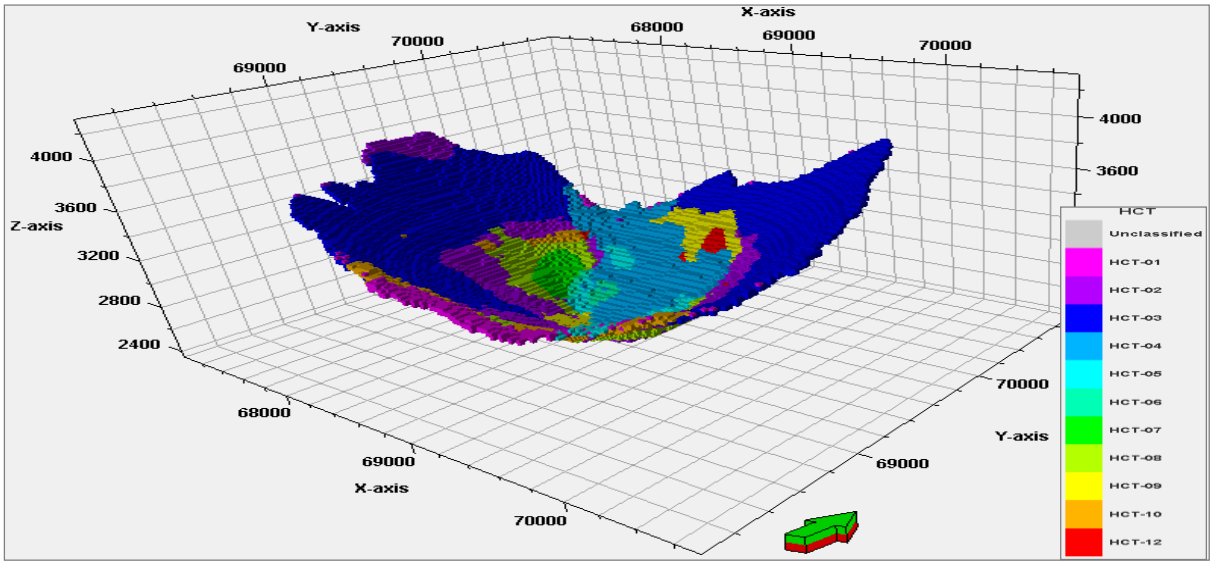

Figure 1 *3D representation of a pit shell defined by geochemical kinetic tests*

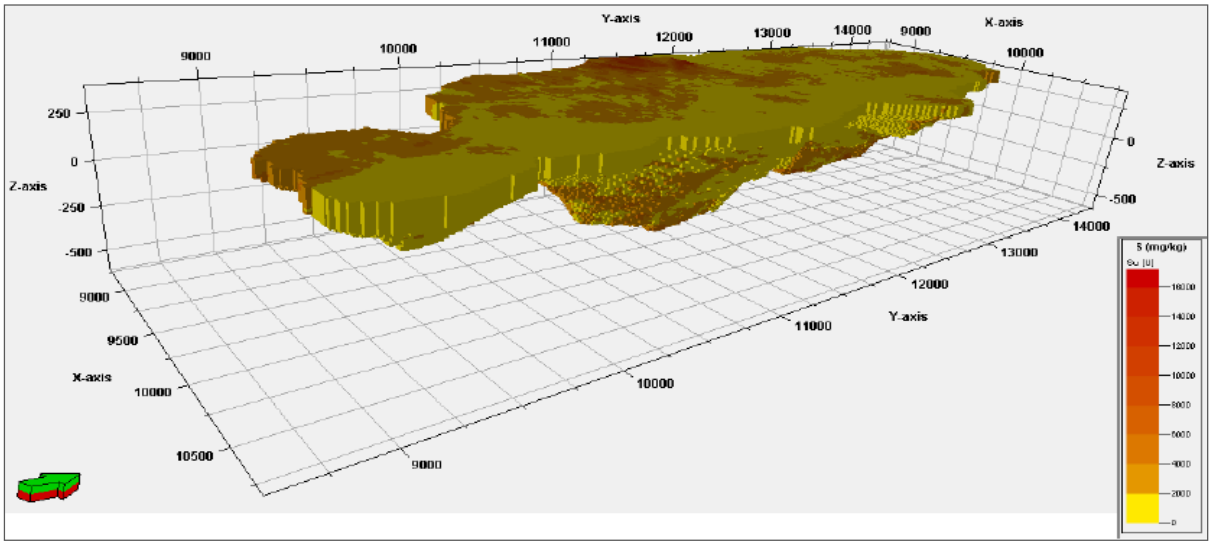

Figure 2 *Sulphur model defining ARD risk within a deposit*

References

Linklater C, Hendry, A and Chapman J (2015) Acid Mine Drainage Risk Assessment Utilizing Drill-Hole Data and Geological Modelling Tools, Proceedings of 10th International Conference on Acid Rock Drainage & IMWA Annual Conference, Santiago, Chile, April 21 – 24 2015, pp. 10.