Geometallurgical tools to understand acid and metalliferous drainage risks for Pacrim mining projects

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ABSTRACT

Determination of the potential environmental effects of historic, current, and future Pacrim mining projects relies on a variety of geometallurgical tools such as ore deposit type, mineralogical studies, whole rock analysis, wet digestion methodologies, leaching tests, acid-base accounting methodologies, and geochemical modelling. These tools provide the data to determine the potential risks for the project in regards to acid and metalliferous drainage (AMD). A number of datasets are presented for Pacrim projects.

Forecasting the effect of AMD for any project is reliant on the development of a conceptual site model integrating the geometallurgical data and then the application of the source-pathway-receptor model to understand the AMD risk. Understanding the potential AMD risks for a project enables informed decisions as to management methodologies, costs, and opportunities to maximise the value of any orebody.

INTRODUCTION

AMD can be split into three general types of water, or geochemical signatures:

- Acid Mine Drainage (low pH, elevated acidity, elevated metals);
- Metalliferous Drainage (neutral pH, elevated metals); and
- Saline Drainage (elevated sulfate, elevated non-acid forming metals/metalloids).

All AMD water types are characterised by elevated sulfate, most often associated with the oxidation of sulfide minerals. This means that sulfur content of the rock is a key variable in determining the AMD risk for a project, although other variables are also of high importance. Richards et al. (2006) indicate that a key driver of AMD risk is geology where ore deposit type and neutralisation potential of the host and country rock represent 30% and 10% respectively of the total hazard score for a site. This clearly demonstrates the importance of geological and geochemical characterisation of a deposit as a screening tool for AMD risk. Unfortunately, it has been noted that inadequate characterisation of materials is a common issue (Richards et al., 2006).

This paper looks at the geometallurgical tools available to characterise a deposit in regards to its AMD risks. Such characterisation work should be a key component of any pre-operational feasibility studies as the presence of AMD can have significant cost and risk implications for any project.

GEOMETALLURGICAL TOOLS

A variety of geometallurgical methodologies and tests are available to understand AMD risk. Such tests are conducted on representative samples. Explanation of the sampling requirements is provided elsewhere (e.g., Price, 2009). Common geometallurgical tests are presented below in Table 1 and are discussed in the presentation together with example datasets.

Geometallurgical Tool	Test	Reference
Geology	Ore Deposit model (depositional environment and mineralogy)	Plumlee (1999)
	Geochemical Abundance Index	Förstner *et al.,* 1993
Acid Base Accounting	Maximum Potential Acidity (MPA); MPA = wt% S x 30.6 Acid Neutralisation Capacity (ANC); Determined by acid digestion and titration; Net Acid Production Potential (NAPP); Where NAPP = MPA - ANC	AMIRA (2002)
Paste pH	1:2 Solid / liquid extract	AMIRA (2002)
Net Acid Generation (NAG) Test	Digestion using H_2O_2 followed by pH measurement and titration to pH 4.5 and 7.0 to determine NAG acidity	AMIRA (2002)
Stored Acidity	Soluble and sparingly soluble acidity determined by 1 M KCl digest and 4 M HCl digest	Ahern et al. (2004)
USGS leach test (5 min)	5 minute leach test with constant shaking	Hageman (2007)
Kinetic Leach tests	AMIRA Column Leach Tests	AMIRA (2002)
	Humidity Cell Tests	ASTM D 5744 – 96 (2001)

TABLE 1 – AMD Geometallurgical Tools

APPLICATION: UNDERSTANDING AMD RISK

Generally, a combination of tests is required to determine the potential AMD risks for a project. These data are then used to classify the sample as to its geochemical natural (acid, metalliferous, or saline drainage). In our experience the use of a process flow approach (e.g., Olds et al., 2015) can improve classification with less uncertain category classifications, reduce analysis costs, and also lower AMD risk. Such data are then used for mine planning and scheduling. Kinetic data are used to forecast the signature of the expected water quality. Such information enables AMD risk to be managed by identification of potential problems prior to the project starting and hence selection of best practicable options. Examples are discussed in the presentation.

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