Improved predictions of acid and metalliferous drainage for greenfield projects

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# ABSTRACT

Extrapolating predictions of acid and metalliferous drainage (AMD) from laboratory to the field face significant challenges due to the heterogeneity of waste rock dumps (WRDs), encompassing variations in particle size distribution, geochemical and hydrological properties of rock fragments, control of experimental conditions and duration, and lack of input parameters reference for numerical models. For greenfield mine sites where the design of WRDs is not finalised, these challenges are further compounded beyond the shortcomings of industry-standard procedures for AMD predictions. Therefore, it is necessary to develop appropriate methods for systematic AMD predictions for greenfield sites. This study investigates how closely the hydrological conditions of waste rock dumps, such as intrinsic permeability, liquid-to-solid ratio, and residence time, can be simulated in the laboratory to derive WRD design parameters. The case study focuses on a greenfield copper-gold deposit in a semi-arid region. Comprehensive mineralogical and geochemical characterisations have been conducted using drilled core samples. The main lithologies consist of metasediments (sandstone, siltstone) and mafic rocks with varying mineralogy. Silicates, such as muscovite, the biotite group, hornblende, and chlorite, provide some neutralizing capacity at low reaction rates, while carbonates may or may not offer neutralizing capacity. To address the limitations of conventional kinetic testing methods, such as humidity cell and AMIRA funnel leaching, this study introduces newly designed kinetic leaching columns that integrate direct oxygen consumption measurements with leachate chemistry analysis and can evaluate AMD risk of the samples at different compaction rates. Comparison of the results will help reduce the duration of kinetic tests, improve understanding of particle size and mineral liberation effects on reaction rates, and enable distinguishing the role of carbonates versus silicates in the neutralisation of acidity through monitoring of CO2 generation. The findings will assist in identifying key parameters affecting the geochemical and hydrogeological performance of WRDs, aiming to provide optimum dump designs before mining activities.