Geoenvironmental indicators using line scan hyperspectral and XRF core analyses for early AMD prediction in Northern Queensland ore deposits, Australia

Enrique Saez Salgado[1], Anita Parbhakar-Fox[1], Nathan Fox[1], Laura Jackson[1]
[1]W.H. Bryan Mining & Geology Research Centre, Sustainable Minerals Institute, The University of Queensland, Brisbane, Australia

Acid and Metalliferous Drainage (AMD) constitutes a major environmental risk in the mining industry, with the potential to cause long-term degradation of soil and water systems. Early identification of AMD risk is essential for implementing effective mitigation strategies during mine planning. This study evaluates the application of line-scan hyperspectral mineralogy, in combination with continuous-scanning X-ray fluorescence (XRF), to predict AMD potential using drill core samples from four mineral deposits in Northern Queensland, Australia. Samples were analysed using the HyLogger™ and Minalyzer core scanner (CS) systems to assess mineralogical indicators associated with AMD, focusing on the presence of potentially acid-forming (PAF) minerals and those with acid-neutralising capacity (ANC). The HyLogger™ Geoenvironmental Index (Hy-GI) was applied to delineate AMD risk domains by integrating continuous downhole thermal infrared (TIR) hyperspectral mineral data with sulphur concentrations obtained from geochemical assays. Of the samples analysed, 46 from the Ernest Henry, Wolfram Camp, and Baal Gammon deposits—characterised by high sulphide content and limited carbonate buffering—exhibited high AMD potential. In contrast, 24 samples from the Mount Isa deposit demonstrated high neutralisation potential. Comparison with traditional static AMD assessment methods, such as Acid-Base Accounting (ABA) and Net Acid Generation (NAG), demonstrated that the combination of hyperspectral carbonate intensity data and sulphur content serves as an effective proxy for identifying both acid-generating and neutralising materials. The Hy-GI indicator successfully differentiated between acid-generating and neutralising zones, serving as a robust early predictor of AMD potential and confirming the value of integrating hyperspectral mineralogy with geochemical data for early-stage AMD assessment. This approach offers a rapid, cost-effective, and non-destructive method for mine waste characterisation and supports more sustainable resource development through improved environmental risk forecasting and mine planning.