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Opportunities for Geoenvironmental Risks Determination, Mitigation and Reuse of Future Mine Wastes Using Geometallurgical Tools

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New approaches to reduce and reuse mine waste across the life-of-mine can be viewed as a strategic opportunity to minimise short- and long-term geoenvironmental risks. However, available tools to undertake geoenvironmental evaluations rely upon limited laboratory chemical tests to study the acid rock drainage (ARD) potential. New technologies are generally used for characterizing the ore and rarely applied to non-ore material. They fall into two sub-sets: i) hand-held instruments, including portable X-ray fluorescence (XRF), Laser-Induced Breakdown Spectroscopy (LIBS) and EQUOtip (which measures mineral hardness); and ii) turnkey machines, including hyperspectral core logging and chemical core scanning instruments. These technologies provide mineralogical, textural and chemical data at the meso-scale, with validation at the micro-scale. All can be used and integrated in the long term to understand how non-ore materials will behave in repositories, forecast geoenvironmental risks, and provide information for potential reuse.

Using visible-near infrared (VNIR), shortwave infrared (SWIR) and longwave infrared (LWIR) hyperspectral data and machine learning tools, new algorithms have been developed at the drill-core scale as a first step towards forecasting ARD potential in an exploration stage. Hyperspectral datasets also provide a unique opportunity to address climate change by studying the potential for CO_2 sequestration of these materials (e.g. active in the LWIR range). Combined with EQUOtip testing, the datasets may help to understand the likelihood and composition of dust generated from future waste landforms. During mining, sensor-based technologies integrated into vehicles, belts, or pipelines can help identify acid- and non-acid-generating materials. The collected data can assist with ore sorting and identify several other elements of environmental and economic interest in real-time. A geometallurgical approach can be applied after mine closure to characterise old legacy wastes. From first-pass tools in a deposit-scale (e.g., geophysical tools) to high-resolution micro-scale instruments like synchrotron beamlines (e.g., XFM), non-ore materials can be mineralogically and chemically mapped. This can resolve elemental deportment to inform mineral processing options in potential secondary mining.