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A Geometallurgical Approach to Recovery of Critical Metals Tellurium, Bismuth, and Tungsten as By-products from a Swedish Gold Mine

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Rapid technological advances have led to the increasing importance of tellurium, bismuth, and tungsten. These critical metals are vital for key technologies, such as solar panels, but have vulnerable and limited supply chains. They are frequently enriched in gold deposits but are understudied and their geometallurgy is poorly understood. Mining and mineral processing are energy-intensive and have a large environmental footprint, and ESG standards are rising. This research focuses on assessing the possibility of recovering tellurium, tungsten, and bismuth from an existing mine. We aim to understand the occurrence of these critical metals, in the case study of Björkdal gold mine in Sweden, and their behaviour through the existing mineral processing, and ultimately aim for onsite by-product recovery. Geometallurgical characteristics of the feed and outputs of mineral processing (four concentrates plus tailings) are assessed through SEM-EDS, XRD, optical microscopy, and bulk geochemistry. Additionally, low-energy recovery using environmentally-benign deep eutectic solvents (DESs) is assessed through leaching experiments.

Target metals almost entirely deport to scheelite (tungsten – 99.8%) and bismuth tellurides (bismuth – 98% and tellurium – 97%). Concentrations and particle characteristics vary significantly between concentrates and tailings. Bismuth tellurides mostly mimic the behaviour of gold in the processing plant due to both mineralogical association with gold and the high specific gravity of these minerals. However, roughly 50% of bismuth tellurides and 70% of tungsten deport to tailings. One concentrate, a product of the gravity circuit, has been identified as a potential target for additional processing steps to recover these metals due to its relatively small volume and good concentrations of large, well-liberated particles of bismuth tellurides and scheelite. Leaching of this concentrate with DESs could allow the recovery of these critical metals on site, diversifying supply and providing extra revenue for the mine, whilst minimising the environmental impact.