Prospects for Byproduct Critical Mineral Recovery from Mine Waste

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Many mineral commodities identified as critical for maintaining supply chains occur as byproducts that typically end up in waste streams. Additional processing at both active and inactive mines could facilitate byproduct recovery. Some byproducts have strong associations with primary commodities such as Ge in sphalerite, whereas as others, such as Te in porphyry Cu ores, have variable deportment among ore-processing outputs. At inactive mines, critical minerals in wastes will vary based on deposit type and their deportment during ore processing. Depending on the age of the waste material, its geological characteristics, and climatic setting, weathering can influence reprocessing strategies for critical mineral recovery. For example, in the Tristate district (Oklahoma), weathering of sphalerite in mine waste results in the formation of the secondary Zn silicate hemimorphite, which sequesters higher amounts of Ge than the original sphalerite. Thus, any reprocessing strategy should consider the importance of hemimorphite, otherwise it will miss a substantial portion of the Ge.

Active mines with long life spans make return on investment for specialized circuits more feasible. For both active and inactive mines, the identification of nontraditional value may be needed for ultimate viability. For example, pyrite concentrates produced during ore processing (or reprocessing) can be leveraged to reduce long-term environmental management costs. In porphyry Cu deposits, pyrite can carry significant Au grades as either native Au or telluride inclusions. Oxidation of pyrite concentrates for Au recovery could also solubilize critical elements such as Te, Ni, or Co, facilitating their recovery. Other examples are gangue minerals, like olivine, pyroxene, and plagioclase in mafic/ultramafic Cu-Ni-Co-PGM deposits, which represent important targets for mineral carbonation—a source of carbon credits. Thus, the most tenable prospects to acquire critical minerals from mine waste will likely combine byproduct critical mineral recovery, additional primary commodity recovery, and improved environmental management.