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Critical Mineral Exploration in Mine Waste

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Mine waste at active, inactive, or abandoned mines represents an unconventional potential resource for critical minerals and other commodities. It warrants investigation because many critical minerals had limited uses in the past, which destined them to waste. Further, many critical minerals are typically recovered as byproducts during mining for primary commodities such as gold, copper, or zinc, which means when they are not recovered, they are relegated to waste.

Factors that influence the endowment of critical minerals in mine waste include the mineral deposit type, commodity deportment during ore-processing and refinement, waste type, and weathering. A mineral systems approach for evaluating mine waste is beneficial in identifying prospective targets for specific critical minerals. Mine waste grade models are being developed using data generated by the USGS's Earth Mapping Resources Initiative Mine Waste Characterization program. When combined with inventory and volume estimates, potential prospects can be identified even if sites have not been sampled.

The economic viability of critical mineral recovery from mine waste presents multi-layered challenges. At active mines, uncertainty in long-term byproduct commodity prices discourages pursuit. At active and abandoned mines, additional recovery of a primary commodity from the waste, such as gold, could facilitate byproduct recovery. Value streams should also be considered broadly. For example, inclusions of gold and critical mineral-bearing phases are common in gangue pyrite, such that production of a pyrite concentrate could reduce environmental costs related to residual waste while also enriching those commodities to economically viable concentrations. Thus, resource recovery could also encourage abandoned mine remediation. Bureaucratic barriers also abound and vary by jurisdiction. For example, in the USA no legal framework exists to recover value from abandoned mines on Federal lands during remediation. Navigating these challenges requires a comprehensive understanding of the scientific, economic, and bureaucratic aspects of individual mine waste sites.