The geochemistry and hydrogeology of mill tailings and waste rock: Implications for mine-waste management and remediation

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Mining and mineral processing generate large volumes of waste, principally as waste rock and mill tailings. Mine wastes generally contain high concentrations of sulfide minerals, principally pyrite and pyrrhotite. Sulfide mineral oxidation within mine wastes frequently produces low pH effluent that contains high concentrations of sulfate and dissolved metals and metalloids. Although the release of acidic drainage containing high concentrations of dissolved metals is considered the most significant environmental concern associated with mining activities, the release of high concentrations of dissolved metals and metalloids in neutral-pH drainage is also an important environmental challenge. Recent field and laboratory studies focused on the geochemical evolution of waste rock and mill tailings provide the basis for the development and refinement of mechanistic approaches and tools for predicting the magnitude and duration of the environmental impacts of mining activities. These tools have been applied to evaluate the potential benefits of modifications to mine-waste management strategies to limit the extent and duration of sulfide mineral oxidation within mine waste disposal areas, and the release of contaminants to natural ecosystems. In addition, strategies have been developed and implemented to mitigate the release of contaminants from existing mine-waste storage facilities. Many of these systems focus on the implementation of low-cost passive remediation approaches, which can be implemented over time spans that are consistent with the anticipated duration of contaminant release in acidic and neutral mine drainage.