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Scaling the hydrological and geochemical processes that control drainage from waste-rock piles: an overview.

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Waste rock is a material that must be excavated to access ore. It is typically disposed of in large piles proximal to the mine site where exposure to oxygen and water promotes oxidation of sulfides, releasing metals, heat and acid. The quality of drainage from waste rock is strongly affected by physical processes that control fluid (water and gas) movement. These processes are complex, due largely to the heterogeneity in grain size, pile structure and mineral distribution. Present assessment methods tend to focus on relatively rapid, small-scale tests which have limited predictive ability at field scales. Acid-base accounting and various leaching procedures such as humidity cells can provide useful information, but fail to represent the larger-scale physical and geochemical processes. Indeed, studies at several sites have shown that the rate of waste rock chemical weathering can be many times faster in smaller-scale experiments than is inferred from observations of outflow in larger-scale piles. This so-called scale effect is often attributed to hydrologic processes, rather than differences between lab and field settings in composition or the chemical environment. Fluid flow in waste rock probably represents the largest source of uncertainty in current predictive efforts to characterize the evolution of solute loadings through time. Modeling could perhaps one day routinely be used to link small-scale assessments to more easily measurable physical attributes such as grain size, general pile structure and grain-size segregation and provide reliable predictions of field-scale behavior without the need for large-scale experiments. This contribution provides an overview of the processes controlling drainage quantity and quality and the relationship between smaller-scale, short-time observations and long-term field-scale dynamics.