Diavik Waste Rock Project: Analysis of measured and simulated acid neutralization processes within a large-scale field experiment

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The geochemical evolution of mine-waste rock often includes concurrent acid generation and neutralization processes. Deposition of mine-waste rock in large, oxygenated, and partially saturated piles can result in release of metals and decreased pH from weathering of sulfide minerals. Acid neutralization processes can often mitigate metals and pH impacts associated with sulfide oxidation. The Diavik Waste Rock Project included large field experiments (test piles built in 2006) conducted to characterize weathering of sulfide waste rock at a scale representative of full size waste-rock piles. Water samples from the unsaturated interior of one of the test piles, constructed of waste rock with ~0.05 wt.% S, were collected using soil water solution samplers and drains at the base of the pile. Field observations indicated pH decreased throughout the depth of the pile during 2008 and 2009 and that carbonate mineral buffering was entirely depleted by 2011 or 2012. Carbonate mineral exhaustion was accompanied by increased concentrations of dissolved Al and Fe in effluent samples collected at the basal drains. These results suggest that dissolution of Al and Fe(oxy)hydroxides occurred after the depletion of carbonate minerals following an acid neutralization sequence that is similar to observations made by previous researchers. A conceptual model of acid neutralization proceses within the pile, developed using physical and geochemical measurements conducted from 2008 to 2012, was used to inform reactive transport simulations conducted in 2017 to quantify the dominant acid neutralization processes within the test pile interior. Reactive transport simulations indicate that the conceptual model developed using the results of field samples provides a reasonable assessment of the evolution of the acid neutralization sequence.