Assessment of the influence of heterogeneity in S, C, and hydraulic conductivity on the geochemical evolution of large-scale experimental waste-rock piles using reactive transport simulations

DAVID WILSON[1*] DANYANG SU[2] RICHARD T. AMOS[3]
K. ULRICH MAYER[2] LESLIE SMITH[2] DAVID C. SEGO[4]
DAVID W. BLOWES[1]

[11]Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada (*dwilson2@uwaterloo.ca)
[2] Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, Canada
[3]Department of Earth Sciences, Carleton University, Ottawa, Canada
[4]Department of Civil and Environmental Engineering, University of Alberta, Edmonton, Canada

Waste rock from mining operations is typically stored in very large piles that can contain materials from many stages of mine development. These structures exhibit substantial variability in mineralogical and physical parameters that influence the geochemical evolution of the waste rock. This heterogeneity requires consideration in any assessment of long-term waste-rock effluent geochemistry. To investigate the spatial distributions in S, C, and saturated hydraulic conductivity (K_S) in waste rock, geostatistical analyses were conducted using spatially located samples collected as part of the deconstruction of a large-scale experimental waste-rock pile. The results of the geostatistical analyses were used to inform two sets of 2-D reactive transport simulations which included heterogeneous spatial distributions of S, C, and K_S to assess the impact of heterogeneity in these parameters on the geochemical evolution of the waste rock and pore water. The simulations were conducted using the enhanced reactive transport code MIN3P with water freezing/thawing capability. The configuration of the experiment enabled collection of effluent samples from multiple locations during a single sampling event facilitating calculation of variance in measured parameters including solute concentrations and flow volumes. Simulated effluent solute concentration variability was within the range of annual variability from measured effluent solute concentrations and simulated flow variability was consistent with measured flow variability. The results indicate that including the mineralogical and physical heterogeneity within multiple simulations can provide representative estimates of the variability in effluent geochemistry and loading necessary for assessment of prediction uncertainty.