Geophysical Research Abstracts
Vol. 21, EGU2019-2984-2, 2019
EGU General Assembly 2019

Waste rock weathering controlled by gas exchange rates in large-scale piles

Bas Vriens, Ulrich Mayer, and Roger Beckie

Department of Earth, Ocean, and Atmospheric Sciences, University of British Columbia, Canada (bvriens@eoas.ubc.ca)

Open-pit mines produce large amounts of waste rock that is typically placed on-site in tall, exposed piles. The weathering and drainage of this waste rock introduces important ramifications for the management of wastewater, as the oxidation of sulfide minerals may generate acidic and metal-rich effluent that requires treatment. Limited availability of oxygen may strongly reduce the weathering rate of sulfidic waste rock, particularly in large piles of poorly permeable material or beneath engineered covers. However, the reaction- and transport limitations controlling pore gas composition in heterogeneous waste-rock piles have been scarcely studied at practice-relevant scales to date.

In the framework of a long experimental research collaboration with the Antamina mine in Peru, we present drainage quality data from - and pore gas distributions within - five meso-scale (10,000 m3) experimental waste-rock piles [Vriens et al., 2019], as well as in two >100 m deep monitoring wells in an operational full-scale dump [Vriens et al., 2018]. Both the experimental piles and the full-scale dump contained localized hotspots with elevated temperatures and reduced O_2 levels. These non-atmospheric pore gas conditions were most pronounced during the wet season, when infiltrating precipitation strongly increased moisture content and suppressed atmospheric gas exchange. Oxygen consumption from sulfide oxidation in the reactive hotspots caused reduced local pore gas pressures relative to ambient atmospheric pressures, which was only partially offset by CO_2 production from carbonate dissolution under acidic conditions. Enrichment of N2 and Ar relative to atmospheric levels and mass-transport calculations indicate that advective O_2 ingress contributed to sustained oxidation in the reactive zones of the waste-rock piles. In contrast, sulfide oxidation rates in the less reactive zones of the pile were not limited by O_2 ingress, independent of the gas transport mechanism, with the exception of fine-grained waste rock at or near complete water saturation.

In summary, spatial and temporal fluctuations in the pore gas distributions in large-scale waste-rock piles appear to be related to chemical reactivity (i.e. sulfide content) and porosity of the waste rock (i.e. particle size) as well as to seasonal variability in pore water saturation (i.e. moisture content). Our work thus suggests that a quantitative understanding of gas transport limitations may lead to improved assessments of waste-rock weathering rates and drainage quality and therefore optimized mine waste management.

[Vriens et al., 2018]: Vriens B.; St.Arnault M.; Laurenzi L.; Smith L.; Mayer K.U.; Beckie R.D. Localized Sulfide Oxidation Limited by Oxygen Supply in a Full-Scale Waste-Rock Pile. Vadose Zone Journal 17:180119. 2018. doi:10.2136/vzj2018.06.0119
[Vriens et al., 2019]: Vriens B.; Smith L.; Mayer K.U.; Beckie R.D. Poregas distributions in waste-rock piles affected by climate seasonality and physicochemical heterogeneity. Applied Geochemistry 100, 305-315. 2019. doi:10.1016/j.apgeochem.2018.12.009.