Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36489

Mobilization of Metal(oid)s and Phosphorus from Urban Streambed Sediments in Response to Porewater Salinization and Freshening

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High de-icing road salt (mostly sodium chloride [NaCl]) usage in cold climates is causing increasing Cl concentrations in many urban streams and in the shallow groundwater beneath them. Although previous studies have shown that salinization can mobilize metal(oid)s and phosphorus (P) in unsaturated roadside soils, it is unclear if similar processes occur within streambed sediments and how subsequent freshening influences metal(oid) and P mobility. To address this research gap, this paper presents laboratory column experiments, informed by field data from urban stream sites in Ontario, Canada, to investigate the impacts of salinization and freshening on the mobilization of metal(oid)s and P. Columns experiments were conducted by exposing streambed sediments to synthetic groundwater with varying Cl concentrations (30 to 5000 mg/L), reflecting the range observed in year-round field sampling of streambed porewater. Results indicate that metal (Al, Pb, Zn) and P mobilization was greatest during freshening when influent Cl concentrations decreased from high (2500-5000 mg/L) to low Cl (30-100 mg/L). In contrast, there was limited mobilization during periods of elevated salinity. Elevated turbidity and increased particulate metal concentrations at the onset of freshening suggest colloidal dispersion is a primary mechanism driving metal release, although P and As mobilization may also be associated with pH increases. During freshening Al, As, Cr, Fe, and Pb concentrations exceeded the Canadian water quality guidelines for protection of aquatic life and P concentrations reached 40 mg/L, which is 400 times greater than the hypereutrophic threshold. Overall, the study highlights the complex interactions among chemical species that regulate contaminant fate near groundwater-surface water interfaces, and the compounding impacts of urban salinization. The results also underscore the importance of accounting for transient dynamics in evaluating biogeochemical processes and ecological risk.