Incomplete Mixing in the Fate and Transport of Arsenic at a River Affected by Acid Drainage

Guerra, P., Gonzalez, C., Escauriaza, C., Pizarro, G., & Pasten, P. (2016). Incomplete mixing in the fate and transport of arsenic at a river affected by acid drainage. Water, Air, & Soil Pollution, 227(3), 73. <10.1007/s11270-016-2767-5> Accessed 23 Dec 2020.

Abstract

Acid drainage is an environmental liability that impacts the quality of surface waters. However, the precipitation of iron and aluminum oxy/hydroxides decreases the concentration of dissolved toxic metals (such as arsenic) in rivers that receive acid drainage. Additionally, hydrodynamic factors (e.g., flow velocity fields and mixing ratios) control incomplete chemical mixing. Despite the occurrence of incomplete mixing in streams, its role on the fate and transport of contaminants has not been explored. We analyzed these processes at the Azufre River (pH 2)–Caracarani River (pH 8.6) confluence, northern Chile. We performed cross-sectional measurements of pH, turbidity, and particle size distributions and sampled water and suspended solids to analyze iron, aluminum, and arsenic. To complement field measurements, mixing experiments and geochemical modeling were performed. We found that there were distinct mixing zones on the field that promoted the precipitation of iron phases (pH >3) or the precipitation of iron and aluminum phases (pH ~5). While iron phases immobilized arsenic by sorption (up to 8700 mg kg–1 of arsenic concentration in the solid phase), aluminum contributed to produce particles with the capacity to resist shear stress (strength factors ~90 %). More than 50 % of the total arsenic was removed from the aqueous phase within 100 m from the junction point, suggesting settling of iron and aluminum particles. These results showed that incomplete mixing was a controlling factor in the fate and transport of arsenic. Fluvial confluences receiving acid drainage are natural reactors that can attenuate toxic metals. A better understanding of the chemical-hydrodynamic interactions in fluvial confluences can lead to new strategies for enhanced attenuation of toxic metals..