

Sulfide Concentration and its Effect on Arsenic Speciation in Groundwater in Rifle, Colorado

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Arsenic occurs naturally in sediment and can be released into groundwater due to iron-reducing bacteria. Once mobile, arsenic becomes a dangerous carcinogen even at low concentrations, inhibiting child mental development and causing bladder and liver cancers. In Rifle, Colorado, the shallow aquifer is contaminated with uranium from mine tailings waste. One remediation strategy was to add acetate, reducing and thus immobilizing the uranium. Unfortunately, acetate also stimulates iron-reducing bacteria, releasing arsenic into the groundwater. Typically, environments with high arsenic concentration have low sulfur concentration. In Rifle, however, sulfur concentrations are also high. The role that sulfur species play in arsenic mobilization has been poorly constrained. During field scale stimulation, we observe the formation of thioarsenate species. Our goal was to better understand the conditions under which these species form in the field. We recreated field conditions in the lab with microcosms containing 5 grams of Rifle sediment and 25 mL of artificial groundwater containing 30 mM bicarbonate, 0.14 mM ammonium chloride, 0.014 mM sodium phosphate and 0.045 potassium chloride. Control samples were autoclaved to kill any bacteria remaining in the sediment. Each bottle had a different sulfide concentration (0.1 ppm, 5 ppm, 50 ppm, 100 ppm and 250 ppm) and over time, sulfide concentration and arsenic concentration were measured. We observed that arsenic concentrations increased with increasing sulfide concentration. We also found that sulfide concentrations generally decreased over time. The highest sulfide concentration sample (250 ppm) of the un-autoclaved bottles had the highest arsenic concentration. Overall, the 50 ppm autoclaved sample had the highest arsenic concentration. These results tell us that sulfide species may be important in mobilizing arsenic species in high sulfur environments and that this process may be abiotic.