Passive Treatment of Metals-Impacted Water Using Sulfate-Mediated Metals Reduction (SMMR)

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Background/Objective. Water used in the mining industry is typically enriched with metals as water is used as the primary solvent for the extraction of minerals associated with solids such as coal, sand, and gravel and liquids that include liquified natural gas and crude petroleum. The resulting chemicals may include but are not limited to metals, heavy metals, sulfate, carbonate, and sulfuric acid. Mine water from a copper mine was impacted with heavy metals, sulfate, fluoride, and total dissolved solids (TDS). Instead of evaluating removal through the accepted practice of batch treatment, SiREM evaluated continuous removal of the constituents using a packed gravel bed reactor.

Approach/Activities. The removal of heavy metals, sulfate, fluoride, and total dissolved solids (TDS) from subsurface mine water was investigated in bench-scale up-flow anaerobic packed bed reactors over an eight-week duration. The native sulfate-reducing community was stimulated using lactate as electron donor and by maintaining anaerobic conditions (-0.5 V to 0.1 V), neutral pH, and a 24-hour hydraulic retention time. A sustainable source of hydroxyapatite was used as a sorption media in one of the three columns to enhance the sorption of heavy metals and fluoride.

Results/Lessons Learned. The use of fixed bed bioreactor is a promising passive treatment strategy for the removal of heavy metals, sulfate, TDS and fluoride from mining impacted water. TDS, heavy metals, and sulfate removal was successfully achieved, along with the notable production of hydrogen sulfide, in up-flow anaerobic packed bed reactors containing sulfate-reducing microbial communities. The removal of fluoride was successfully achieved in the hydroxyapatite amended column. The findings from the bench-scale investigation are translatable to pilot- and full-scale implementations.