Dominant Trace Metal Removal Products in a Hard Rock Mine Discharge Bioreactor[1]

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Abstract: Two vertical flow bioreactors (VFBR) were constructed in 2005 to treat a low flow (< 15 L/min), net-acidic ferruginous hard rock mine drainage. The VFBR were intended to remove metals predominantly through precipitation as insoluble sulfides. In the years 2005-2014, median influent quality was pH 3.3, 45 mg/L Fe, 8.6 mg/L Al, 2.6 mg/L Mn, and 320 mg/L SO_4^{2-}. The VFBR were effective at producing circum-neutral, net-alkaline water and removing an average of 225 kg Fe/yr, 67 kg Al/yr, and 985 kg SO_4^{2-}/yr. In addition, the low concentrations of Cd, Cu, and Zn were consistently removed to below detection limits. Prior to decommissioning, solid samples were collected at depths of 7.5 cm, 15 cm, 30 cm, and 40 cm of the southern VFBR. Sequential extraction procedures and acid volatile sulfide measurements were used to evaluate dominant trace metal removal products in all samples. Large total concentrations of Al, Cd, Cu, Fe, Mn, Pb, and Zn were found throughout the system, with concentrations generally decreasing with depth. Precipitation as sulfides tended to increase with depth for most of the metals, except for Al and Mn. Complexation with labile organic material and adsorption were the dominant removal pathways for Al and Mn, respectively. Despite Pb concentrations below detection limits in the influent, substantial concentrations were found in the carbonate and sulfide fractions within the substrate. Analyses demonstrated that by a depth of 15 cm, most of the metals retained within the substrate were in stable, stationary fractions that should prevent migration of pollutants to receiving streams.

Additional Key Words: Bacterial sulfate reduction, sequential extraction, acid volatile sulfide

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