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Trace metal sequestration in an aging passive treatment system for abandoned coal mine drainage

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The primary goals of passive treatment systems for abandoned mine drainage (AMD) are the removal of the major metal species, Fe (and Al), and the addition of alkalinity to raise pH. The precipitation and sedimentation processes controlling deposition in these systems vary depending on the chemical/biological conditions. Fe oxyhydroxides are dominant under aerobic conditions, metal sulfides may form under anaerobic conditions, and Al hydroxysulfates precipitate at higher pH. While these removal processes for the major metal species are well understood, the behavior of trace metals has not been extensively studied. We investigated the sequestration of trace metals including Zn, Ni, and Co within the sediments of a passive treatment system for AMD in the Shamokin Creek watershed of the western middle anthracite coalfield of Pennsylvania, USA. The 20-year-old treatment system, consisting of an oxidation pond followed by three vertical flow wetlands (VFWs), treats water from an AMD discharge with an initial pH of 4.1 and $[Fe_{tot}]$ = 15 mg/L.

In order to compare how different processes occurring within the treatment system affect the fate and transport of trace metals, we collected sediment cores from the oxidation pond and the third VFW in which deposited sediments overlay the limestone and mushroom compost at the bottom of the pond. X-ray fluorescence (XRF) was used to determine elemental depth profiles for each core, and additional elemental data were acquired from digests of sediment samples. Powder x-ray diffraction (XRD) was used to probe changes in mineralogy with depth. Distinct differences in the distribution of trace metals between the cores – as well as their abundances relative to the major metal species - offer clues about the biogeochemical pathways that lead to sequestration of trace metals in the passive treatment system.