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Disturbance and recovery of metal dynamics in a photosynthetic microbial biomat following exposure to acid mine drainage

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Environmental conditions affect metal dynamics within nature-based treatment solutions. Gaining a mechanistic understanding of these processes provides information needed to explore potential applications for remediation. We investigated metal cycling in the microbial biomat harvested from unit process open water (UPOW) constructed wetlands under two very different but realistic conditions. Firstly, experiments in laboratory flow-through bioreactors amended with field biomat showed diel (day-night) cycles of pH from circumneutral to basic, controlled by photosynthesis and respiration, and diel cycles of dissolved oxygen (DO), Zn, Cu, and Mn analogous to the uncontaminated field wetlands. Higher metal concentrations were then introduced under low pHs (4-5) representative of acid mine drainage (AMD). Diel cycles were suppressed when exposed to synthetic AMD (derived from a mine drainage in Idaho Springs, CO). Accumulation of Zn and Cu occurred at the surficial 0-5mm layer of the biomat with limited disturbance at the deeper 20-25mm layer. Sequential extractions demonstrated that Zn was associated mostly with labile phases and Cu was associated with both labile and oxidizable phases. Importantly, diel cycles recovered after ~2 weeks of introduction of regular nutrient media following the synthetic AMD exposure. pH and DO diel cycles, as well as metal (Zn, Cu, Mn, Al) diel cycles, were similar to those seen before AMD exposure. There were also ecological shifts in the surficial microbial community after exposure to synthetic AMD. This information helps identify the potential changes in UPOW constructed wetlands when exposed to complex mining-impacted waters and furthers our understanding of the geochemical and ecotoxicological perspective of contaminant disturbance and recovery in a photosynthetic, nature-based water treatment system.