Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30559

Transition Metal Recovery using Manganese-oxidizing Microbes and Recycled Carpet Fiber

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Continued increase in demand for metals in today's society requires a portfolio of extraction and remediation strategies to ensure metals are mined and recovered efficiently while protecting surrounding environmental quality. Treatment processes for metals in mining waste streams can often be cost prohibitive and energy intensive. Therefore, passive remediation strategies using natural materials have the potential to provide affordable solutions for removing metals from aqueous waste streams, which is important from regulatory and environmental quality perspectives. Microbially-mediated strategies that remove metals from aqueous waste streams via sorption and/or oxidation-reduction reactions show promise as eco-friendly, cost-effective solutions. Here we demonstrate the use a Mn-oxidizing fungi, isolated from the Soudan Underground Mine State Park, MN, a high-salinity, mine-impacted environment, to sequester transition metals Mn, Co, Cu, and Ni. Additionally, we demonstrate the use of recycled carpet fibers to support dense biomass growth and promote rapid Mn(II) oxidation rates resulting in the formation of Mn(III/IV) oxides. The addition of fibers promoted increases in metal uptake in the presence of 500 µM Mn(II) along with 20 µM Co(II), 20 µM Cu(II), *or* 20 µM Ni(II) as well as with all metals combined where sequestration increased by as much as 6-fold for Mn and 3-fold for Co, following 10 days of incubation. X-ray fluorescence (XRF), scanning electron microscopy (SEM) and confocal imaging of the biofilm show a complex network of fungal hyphae with Mn oxide particles and Co, Cu, and/or Ni sequestered throughout. Recycled carpet fibers benefit system performance by encouraging maximum fungal growth and subsequent Mn oxide formation while keeping the solid mass in a cohesive phase at the air-water interface. Additionally, this strategy provides a use for spent carpet fibers or similar waste manufactured fiber materials.