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Microbially induced metal immobilization in secondary cements at a historic gold mine

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Microbially-mediated mineral precipitation has the potential to significantly alter geochemical conditions in the context of contaminant removal. Metal contamination, specifically in the form of acid mine drainage (AMD), is a concern for thousands of sites across Canada. This study investigates the ability of microbial communities to immobilize dissolved metals through the precipitation of secondary cements at the historic Cordova Gold Mine located near Peterborough, Ontario. The sulfidic tailings piles found on site host abundant iron- and sulfur-oxidizing bacteria including *Acidiferrobacter* and *Acidithiobacillus ferrooxidans*. Using inductively coupled plasma-optical emission spectrometry (ICP-OES), groundwater sampled adjacent to the piles was found to contain elevated concentrations of transition metals Fe (1366 mg/L), Cu (8.8 mg/L), Co (3.7 mg/L), and Zn (1.6 mg/L), likely mobilized by microbial oxidation of the sulfide minerals in the tailings. It is hypothesized that these metals are being immobilized in hardpan found adjacent to the piles, and that bacteria may be playing a role in this secondary mineral precipitation. Petrographic analysis of the hardpan thin sections indicate that they are cemented by iron oxide minerals. Back scattered electron-scanning electron microscopy (BSE-SEM) of the same thin sections indicate that some areas of the cement contain microfossil-like textures, which differ in composition from the surrounding cement when analyzed using energy dispersive spectroscopy (EDS). Preliminary results indicate that the microfossils are composed of jarosite ($KFe_3[SO_4]_2[OH]_6$) while the surrounding cement is identified as goethite ($FeO[OH]$). Jarosite is commonly precipitated by iron-oxidizing bacteria and can host various transition metals including those identified in the site groundwater. The hardpan also hosts sulfur- and iron-reducing bacteria, which may also be contributing to the immobilization of dissolved metals in the form of secondary cement precipitation. Overall, these results demonstrate local-scale microbial metal mobilization and re-precipitation processes, which are of importance to developing bioremediation strategies for AMD-contaminated sites, and have broader applications to understanding microbe-mineral interactions and their impact on metal cycling in various environments.