Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35544

Metal-Binding Ligands Rather Than Redox Active Metabolites Are Essential to Microbially-Induced Corrosion of Cobalt

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Microbially-induced corrosion (MIC) has been well-studied in the context of damage to iron-bearing infrastructure, where microbes can solubilize elemental iron using redox-active metabolites such as phenazines. Whether such pathways solubilize economically critical cobalt remains poorly understood. We hypothesized that secondary metabolites produced by the model bacterium *Pseudomonas chlororaphis* subspecies *aureofaciens* associated with MIC of iron could corrode cobalt by oxidation (*i.e.,* phenazines) or by acting as a ligand (*i.e.,* cyanide). One-week incubations of live cells with Co(0) wires led to 20-30% mass losses and ~2200 µM Co(2+) recovered in solution, upwards of 3-fold higher than filtered cultures and sterile medium. Mutants lacking the capacity for phenazine and cyanide production corroded as much cobalt as wild-type cells and phenazine standards alone did not induce corrosion, demonstrating these metabolites do not contribute to MIC. Corrosion assays with metabolite mixtures lacking phenazines under anoxic conditions confirmed that oxygen oxidizes Co(0) and unidentified metabolites drive MIC by keeping Co(2+) in solution, likely limiting cobalt oxide precipitation. This revised explanation reinforces the need to consider connections between abiotic and biotic reactions in the MIC of non-ferrous metals. Understanding these mechanisms is critical to reframing MIC as more than an environmental concern and optimizing sustainable cobalt recovery strategies for solid waste that rely on naturally-occurring microbial metabolites.

