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A bioelectrochemical system for metal and metalloid recovery

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Advancements in the field of bioelectrochemistry offer opportunities to examine microbially mediated processes to recover critical minerals and other commodities from mine wastes. Processes that selectively precipitate a dissolved elements from the surrounding solution are advantageous to recovering a specific element, especially when separation is required from a metal-rich matrix.

Bioelectrochemical systems are electrochemical cells that use bacterial extracellular electron transport to catalyze reactions on electrode surfaces. Bioelectrochemical systems provide an opportunity to explore metal recovery through reductive metal precipitation. We use a potentiostat to poise an electrode at a constant voltage to promote microbially mediated reduction of target elements.

Using a pure strain of Shewanella oneidensis MR-1, an organism known to directly utilize electrons from an electrode, we explore the experimental range of bioelectrochemical systems by comparing the experimental behaviors of individual elements to calculated reduction potentials. Candidate elements include uranium, tungsten, vanadium, chromium, arsenic, antimony, and tellurium. We also explore targeted reduction in mixed-element solutions using a bioelectrochemical system based on the results of the individual element experiments. Ultimately, these experiments will inform how bioelectrochemical systems can be used to enhance recovery of commodities from aqueous, metal-rich mine waste.