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Biosorption of critical metals in simulated ultramafic environments using cyanobacteria

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The demand for critical metals presents a unique challenge, with the need to maintain both global economic growth and environmentally sustainable mining operations. Tailings contain low concentrations of critical metals and recovery of these metals may become valuable as sources of high-grade ore become fewer. Biosorption of metals may be an attractive method of concentrating metals leached from tailings. Cyanobacterial extracellular polymeric substances (EPS) can bind metals from solution; however, little is known about the metal biosorption potential of cyanobacteria in ultramafic tailing environments.

This study examines biosorption of nickel and cobalt by cyanobacteria in a simulated ultramafic environment. In a thirty-day experiment, a strain of *Synechococcus leopoliensis* was exposed to nickel and cobalt (Ni-only: 10 mg/L, Co-only: 10 mg/L, Ni + Co: 10 mg/L each) in nutrient-rich and nutrient-deficient growth conditions, with the nutrient deficient environment representing typical phosphate and nitrate concentrations in ultramafic environments. A previously established EPS extraction protocol[1] was adapted to work with cyanobacteria. Raman and Fourier transform infrared spectroscopy results indicate more functional groups generate more pronounced peaks in nutrient enriched solutions compared to nutrient deficient solutions. Inductively coupled plasma-mass spectrometry (ICP-MS) measurements of dissolved elemental concentrations indicated that Co and Ni removal from solution occurred quickly, with maximum removal achieved on either Day 1 or Day 3 of the experiment for all systems. Cobalt sorption was greater in the nutrient enriched systems (up to 49%) compared to the nutrient depleted systems, while the opposite was true for Ni (up to 43% removed in nutrient deficient systems). Nickel and cobalt concentrations increased after Day 3, indicating metal desorption. Ion chromatography results indicated that neither nitrate nor phosphate was depleted in any system during the 30 days. These results indicate that biosorption by *S. leopoliensis* can rapidly remove Co and Ni from solution. While increased nutrient availability may increase EPS production, metal sorption was still successful under the nutrient depleted conditions replicating ultramafic mine sites. These findings provide a valuable indication of metal sorption conditions for metal recovery from tailing leachate or other low-concentration metal sources.

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