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Enabling In-Situ Leaching of Critical Minerals via Electrical Reservoir Stimulation

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The demand for critical minerals (e.g., Cu, Ni, Co, Li, REEs) is projected to grow as a result of attempts to decarbonize our current energy infrastructure [1]. The mining industry attempts to keep up with this demand via developing ever-so lower ore grades and deeper ore bodies, lowering efficiency and increasing comminution costs [2]. A more promising approach to targeting lower ore grades and deeper ore bodies is that of in-situ leaching (ISL), which bypasses blasting, stripping, grinding, and crushing expenses by directly moving the hydrometallurgical steps into the ore body itself [3]. ISL is most limited by a given ore body's permeability and porosity [3]. Eden's Electric Reservoir Stimulation (ERS) offers a cutting-edge and environmentally conscious method to induce fractures within an ore body. This novel approach utilizes alternating current, direct current, and/or pulsed power to significantly increase rock permeability and reactive surface area, facilitating enhanced leaching processes.

In this study, we observe that the fracturing occurs along pre-established planes of weakness, such as mineralized veins, via µCT. Furthermore, we test whether ERS increases the efficiency of ISL via increasing permeability and preferentially exposing the minerals of interest along vein boundaries to lixiviants. Cu- and Ni-rich rock cores were fractured using ERS and leaching experiments were conducted to investigate the increase in leaching efficiency, using organic and inorganic lixiviants. We grounded our study by comparing the samples that undergo ERS to mechanically fractured samples by a) matching the amount of energy spent on ERS to the energy spent on mechanical fracturing, and b) grinding the ERS- and mechanically-fractured samples to equivalent grain size. During the experiment, aqueous leachant was sampled periodically and analyzed for pH, metal content, and electrical conductivity. Statistical comparisons of the various fracturing techniques' leaching efficiencies were subsequently calculated.

[1] Calderon et al., 2024, *Renewable Sustainable Energy Rev.* **[2]** Calvo et al., 2022, *Environ. Dev.* **[3]** Sinclair and Thompson, 2015, *Hydrometallurgy*.