Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23538

Assessing the relationship between spectral induced polarization and geochemical alteration of zero valent iron during corrosion

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Spectral Induced Polarization (SIP) is a non-invasive geophysical method which could complement existing subsurface characterization methods as it captures complex electrical conductivity and phase responses representative of solution conductivity, surface conductivity, and mineral polarization. While SIP is increasingly employed in both lab and field settings for subsurface monitoring, there is a need for comprehensive characterization of SIP signals within the context of geochemical changes. Zero valent iron (ZVI), a remediation technology of interest, is well-represented within existing SIP studies due to its high polarizability [1-5]; however, the impact of geochemical alteration processes during corrosion on the SIP responses are not fully understood. Thus, this study interrogates ZVI and its oxidation products at a range of particle sizes to link changes in SIP responses to geochemical reactions.

Materials were first characterized in static column experiments before the largest (20-mesh, < 841 µm) and finest (0.1 µm) particle sizes were selected for long-term flow experiments where geochemical conditions and reactions were monitored. The 20-mesh ZVI material exhibited phase peaks between 1500 and 7000 Hz, whereas nano ZVI (nZVI) peaked between 1 and 30 Hz. Although theory predicts that a smaller particle size would peak at higher frequencies [6-7], we hypothesize that the nZVI particles are aggregating to create larger overall particles and greater connectivity, which is measured at a lower frequency relative to the 20-mesh ZVI. Identifying distinguishable changes in SIP responses over time relative to geochemical properties, like reductive potential, could be critical in assessing the efficacy of ZVI in permeable reactive barriers or injections for the reduction and sequestration of environmental contaminants.

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