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Contrasting Mechanisms for Fe(II)-Mediated Nickel and Cobalt Dissolution from Laterites

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An increase in mining is required to meet the Ni and Co demand for the expansion of renewable energy infrastructure. Laterites contain the majority of Ni reserves, and a sizeable amount of Co, but lag sulfide-hosted Ni deposits in terms of production. This disparity is due to the higher economic and environmental costs of extracting Ni (and Co) from laterites. Here, we examined the role of aqueous Fe(II) in mobilizing Ni and Co from several laterite ore samples to assess the suitability of ambient (room temperature, circumneutral pH) ferrous leaching as an alternative approach to more traditional high capital, high operating expenditure laterite processing methods (e.g., high-pressure acid leaching). Our results show that the proportional Co extraction in all tested laterite samples is higher than that of Ni. The speciation of each metal before and after reaction with aqueous Fe(II) was quantified with X-ray absorption spectroscopy (Ni and Co K-edge). In the samples investigated, Ni is primarily hosted in iron oxides and clays whereas the majority of Co is incorporated in Mn oxides. After reaction, the small amount of Co that remains in the solid residue is found in refractory iron oxides and silicates. We find that Fe(II) readily reacts with Mn oxides via reductive dissolution and thus releases hosted metals. Although iron oxides and clays are susceptible to Fe(II)-catalyzed recrystallization, as evidenced from changes in an iron isotope tracer, the extent of reaction for these phases, and hence metal release, is less than that found for Mn oxide-hosted metals. Our results suggest that ferrous iron leaching may be a viable laterite processing method, particularly for deposits containing high Co to Ni ratios.