Controls on Goethite Recrystallisation with Applications to Metal Mobility in Ni-Laterites

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Laterites host the majority of the world's Ni within the crystal structure of goethite (FeOOH) but traditional mining techniques for these deposits require energy intensive processing which creates deleterious carbon emissions and acidic waste. The recrystallisation of goethite catalysed by $Fe(II)_{aq}$ at ambient conditions (i.e., 22 degrees C, atmospheric pressure, pH 7) may enhance metal release in laterites and hence offer an environmentally friendly alternative for metal extraction. However, the parameters that affect the coupled dissolution-precipitation reactions of goethite require further understanding. Here we isolate such parameters (e.g., crystallinity and Al-substitution) and examine the effect on Fe(II)-catalysed recrystallisation, then, apply these data to induce mineral recrystallisation in natural laterite ore to determine if it facilitates the release of Ni and Co.

We synthesised a range of goethite materials with *(1)* varying crystallinity (no metal substitutions), *(2)* varying Al-substitution (but constant crystallinity), and reacted these in ^{57}Fe-enriched $Fe(II)_{aq}$ solutions. Samples were analysed by powder X-ray diffraction for mineral phase identification and determining crystallite size; high resolution scanning electron microscopy for observing particle size and morphology; and inductively coupled plasma mass spectrometry to measure isotopic abundances and quantify recrystallisation. Results showed goethite recrystallisation was inversely proportional to the initial crystallite size, and inhibited by the presence of Al.

The same reaction conditions were applied to natural samples of laterite ore and metal release was indeed activated by Fe(II)-catalysed recrystallisation, with ~5% of the total Ni released and ~55% Co, after 60 days. By simulating a flow-through system, the metals in solution were collected every 14 days then the remaining solid laterite sample was reacted again with $Fe(II)_{aq}$. The metal release improved to ~10% Ni and ~70% Co after 4 reaction cycles. Whilst work to increase yields is ongoing, the successful metal release shown here establishes the potential towards a greener future for industrial mining of laterite ore.