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Nickel release from nickel rich hematite through Fe(II)-catalysed recrystallisation

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Iron (oxyhydr)oxides like goethite and hematite are abundant in Earth's surficial environment [1]. They host a variety of trace elements including nickel (Ni) and cobalt (Co), which are essential for modern green technologies (e.g., solar panels, windmill turbines and batteries) [2, 3]. The majority of the world's Ni reserves are associated with iron (oxyhydr)oxides [4]. Compared to conventional Ni extraction techniques that often involve high-pressure acid leaching, Fe(II)-catalysed recrystallisation has been shown to enhance the release of Ni from goethite and hematite under ambient and circumneutral pH, thus being an environmentally benign strategy for Ni extraction. This however, requires a thorough understanding of the relationship between Fe(II)-catalysed recrystallisation and Ni partitioning. Although previous work has shown that Ni can inhibit recrystallisation of goethite and negatively impacts the release of Ni [5], the behaviour of Ni cycling in hematite, and ways to improve Ni release remain unclear. We show that up to 23% of Ni can be leached from hematite samples doped with 1 mol% Ni during batch reactions whereas only 3% are leached in control experiments without Fe(II). In order to explore if aqueous Ni interferes with the hematite recrystallisation, we reacted hematite in aqueous Ni(II) with and without the presence of aqueous Fe(II). We discovered that, similar to goethite, inhibition of hematite recrystallisation directly relates to the labile Ni(II) concentration in the recrystallisation solution. Hence, higher Ni recovery could be achieved with continuous removal of surficial, lightly bound Ni on the hematite surface. Therefore, to increase Ni release and Ni extraction efficiency, we employed a continuous flow scheme. During these, Fe(II) promoted recrystallisation and mild acid wash sequences are alternated to optimise Ni release. Exploring these alternative Ni extraction and recovery pathways can help reduce the environmental impact of mining and supply the resources needed for green technologies.

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