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Phosphorus association with goethite: Effects of Fe(II)-catalysed recrystallization

Naturally occurring goethite is typically associated with impurities such as SiO2, Al2O3 and P2O5. These may be found with goethite through mechanisms including direct substitution or coprecipitation of nanocrystalline phases. Understanding P incorporation in goethite has significant implications for Australia's iron ore industry as it lowers their commodity value. The current study tests a novel low-temperature technique to extract P impurities from synthetic goethite phases under O2-free ambient conditions by utilising Fe(II)-catalysed recrystallisation. The objective of this study was to examine the effect of the Fe(II)-catalysed recrystallisation of goethite on the geochemical behaviour (mobility and speciation) of co-associated P. To achieve this, we tracked changes in labile P (aqueous and 1M NaOH extractable) concentrations over time in goethite suspensions which were reacted with Fe(II)aq for 14 days under circumneutral pH conditions and room temperature conditions. Temporal changes in Fe mineralogy were investigated via synchrotron-based X-ray absorption spectroscopy. Iron K-edge extended X-ray absorption fine structure (EXAFS) spectroscopy confirmed goethite as the only mineral phase in P-free treatments while goethite (~86%) and feroxyhyte (~14%) were the main phases in 1.0% P-containing treatments after a 14-day reaction with Fe(II)aq. According to our findings, the treatment of P-goethite with Fe(II) for a duration of 7-14 days, followed by a 24-hour extraction of the reacted solids using 1M NaOH, results in the removal of approximately 79.5% of the initial P content. This removal encompasses both the aqueous fraction (~4.5%) and the surface adsorbed fraction (~75%) from the 1% P-bearing mineral phase. Notably, this approach demonstrates an improvement in P extractability, with approximately a 10% increase compared to the 1% P-goethite sample that was not reacted with Fe(II).

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