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How does silica affect Fe(II)-catalysed transformation of ferrihydrite and lepidocrocite?

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Ferric iron (Fe(III)) minerals, such as ferrihydrite and lepidocrocite, can be reduced to ferrous iron (Fe(II)) through microbial reductive dissolution under reducing soil conditions, to form dissolved Fe(II) or mixed Fe(II)-Fe(III) mineral phases. The dissolved Fe(II) catalyses iron mineral transformation to more crystalline iron phases. Silica (Si), in the form of silicic acid, is an ubiquitous component of natural soil solutions and is known to hinder the iron mineral transformation process. However, the mechanisms and the mineral phases that are formed during ferrihydrite and lepidocrocite transformation in the presence of Si remain unclear. We reacted ferrihydrite, Si-ferrihydrite co-precipitates, lepidocrocite and Si-adsorbed lepidocrocite with 0.3 mM and 3 mM isotopically labelled ^{57}Fe(II) for four weeks. At six time points, we sampled the solid and the aqueous phase, to follow iron mineral transformation by X-ray diffraction and dissolved Fe(II) dynamics. In addition, we tracked the iron atom exchange between the aqueous and the solid phase by measuring the $^{57/56}$Fe isotope ratio in filtrates and dissolved solid phases. Our data demonstrates the hindering effect of Si on Fe(II) catalysed ferrihydrite and lepidocrocite transformation. The presence of Si decreased the initial Fe(II) adsorption and strongly slowed down the iron atom exchange, especially in the lepidocrocite treatment. Collectively, the results of this study demonstrate, how Si can impact iron mineral transformation in soils with different Fe(II) release potentials under reducing conditions.