



How does silica affect Fe(II)-catalysed transformation of iron oxyhydroxides?

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Relevance

- Iron oxyhydroxides can **control trace element mobility** under redox fluctuating conditions¹
- Silicic acid is a **weathering product** of silicate rocks (90 % of earth's crust!) and is ubiquitous in soil solutions
- The precipitation of ferrihydrite in the presence of silica leads to **ferrihydrite-silica co-precipitates**²
- In **redox active environments**, recurring Fe(II) oxidation leads to the regular precipitation of **impurity bearing ferrihydrite** during oxic periods

We are only showing a **reduced dataset**



Photo 1: Redox features in a rice paddy soil at our field site in Thailand

Co-precipitated silica alters the **mineral phase** of ferrihydrite transformation products, without hindering **iron atom exchange**

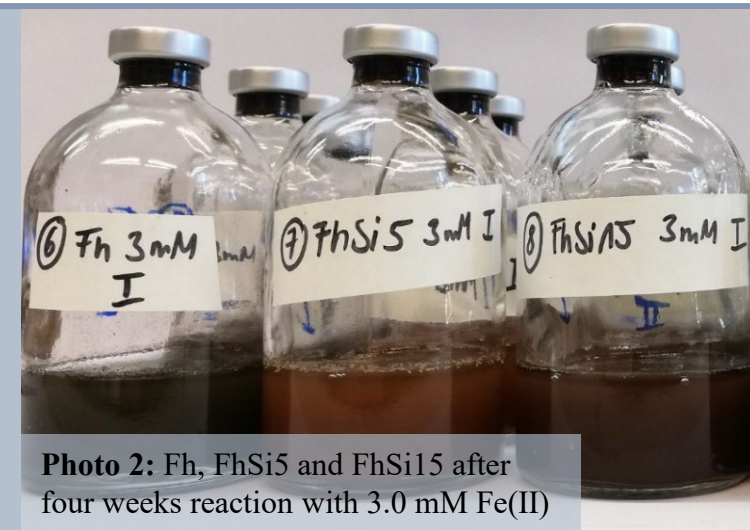


Photo 2: Fh, FhSi5 and FhSi15 after four weeks reaction with 3.0 mM Fe(II)

Experimental setup – Model study

- Minerals: Fh and FhSi co-precipitated with 5 % and 15 % Si/(Si+Fe)
- Aqueous: ⁵⁷Fe labelled Fe(II), 0.3 and 3 mM
- Time: 4 weeks, six sampling points (solid and aqueous phase)
- Analyses: XRD, ICP-MS

X-ray diffraction: Mineral phase fractions

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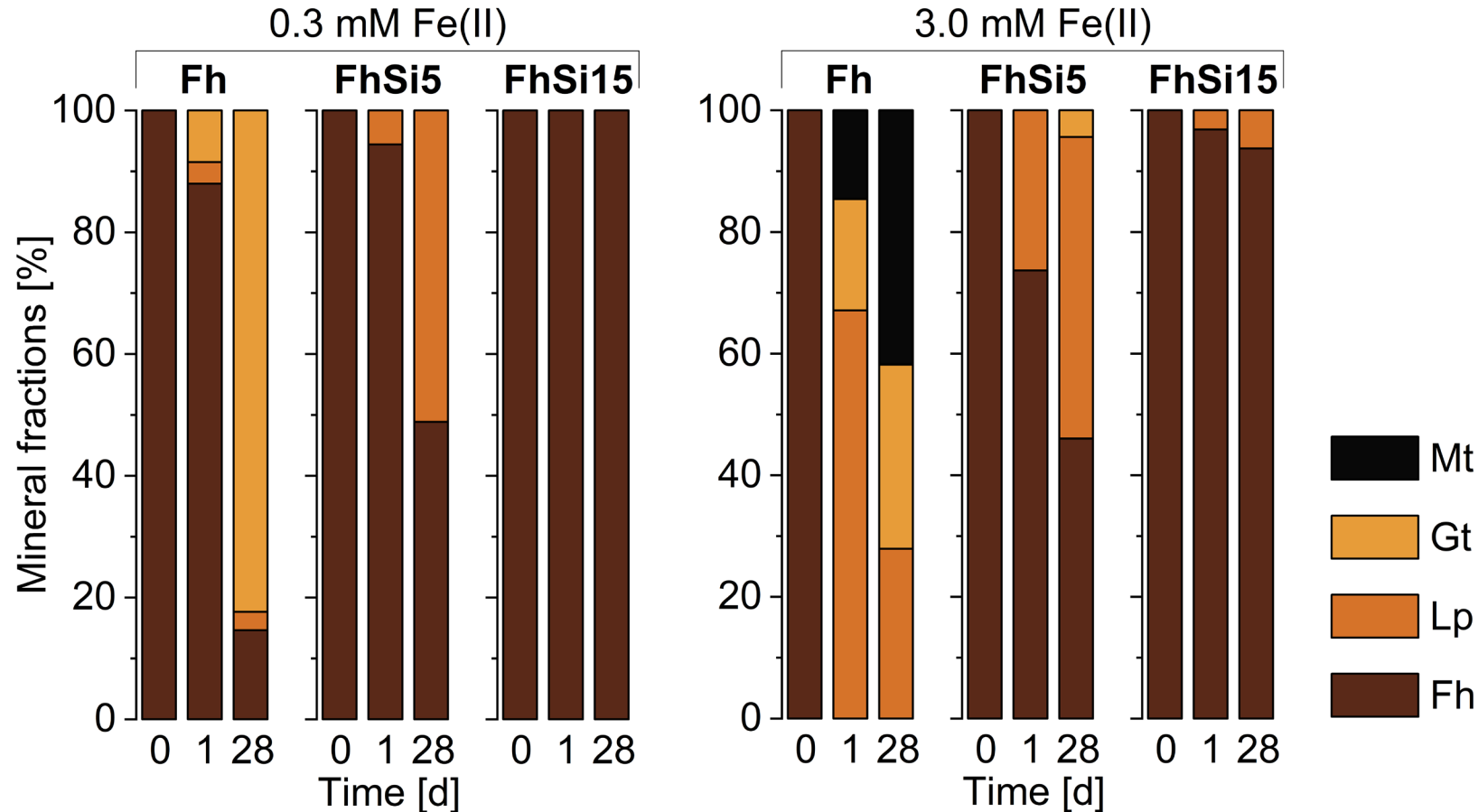


Fig 1: Mineral phase fractions in solids before and during the reaction with 0.3 mM (left) and 3.0 mM (right) Fe(II) for 1 and 28 days, determined by XRD and Rietveld refinement. The sample Fh 3.0 mM additionally contained trace siderite (<1 %) after 28 days. Abbreviations: Fh = ferrihydrite, FhSi5/15 = ferrihydrite silica co-precipitates with Si/(Si+Fe) = 5 % and 15 %, Lp = lepidocrocite, Gt = goethite, Mt = magnetite, d = days.

**Silica hinders
ferrihydrite
transformation**

The hindering
effect is
**stronger for
higher silica
concentrations**

ICP-MS: ^{57}Fe fraction in aqueous phase

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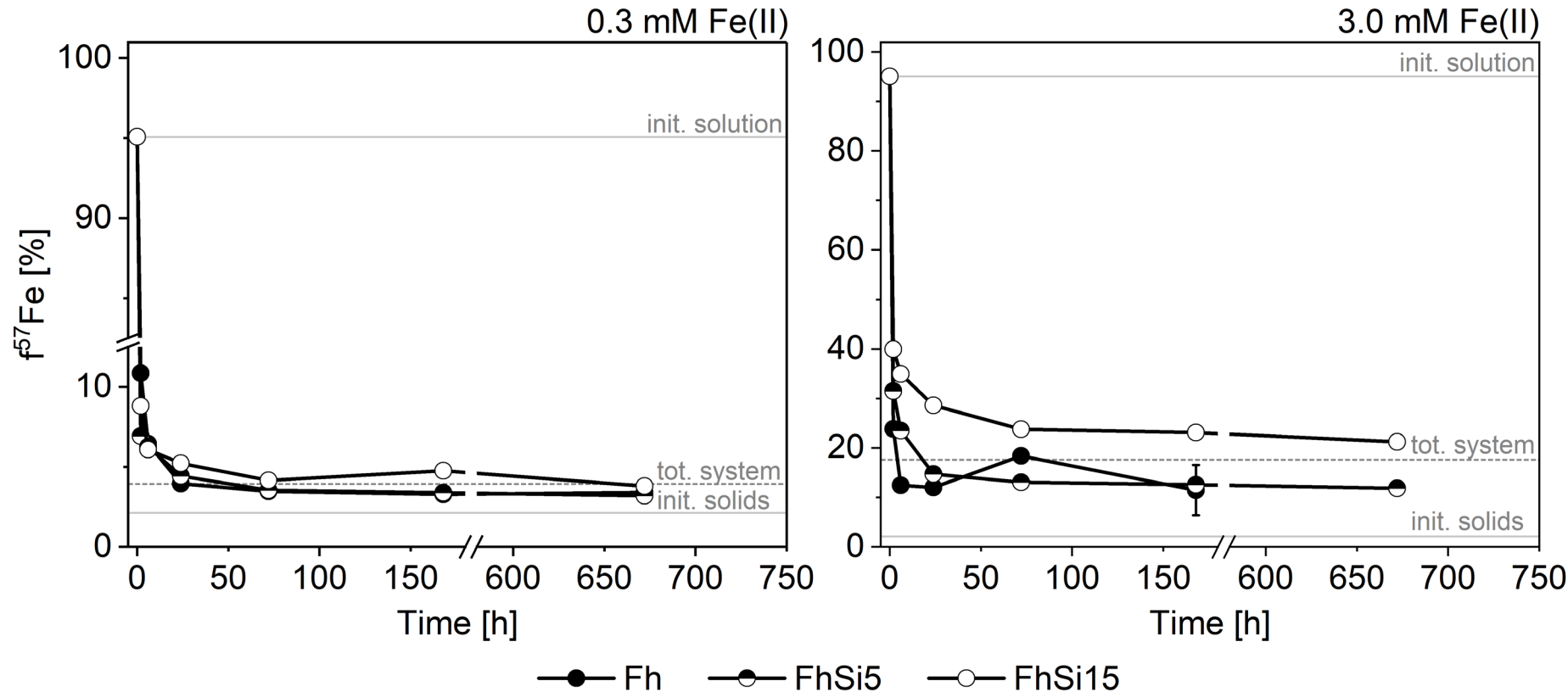


Fig 2: Isotope fraction of ^{57}Fe in aqueous samples ($<0.22\ \mu\text{m}$) before and during the reaction with 0.3 mM (left) and 3.0 mM (right) Fe(II). Error bars show the standard error between experimental triplicates, errors $<1\%$ are smaller than the symbols and are not shown. For Fh 3.0 mM, data is only shown until 1 week (168 h), as aqueous Fe concentrations were too low ($<20\ \text{ppb}$) to facilitate reliable Fe isotope measurements. Abbreviations: Fh = ferrihydrite, FhSi5/15 = ferrihydrite silica co-precipitates with 5 % and 15 % Si/(Si+Fe), h = hours.

Despite hindered transformation of ferrihydrite-silica, iron atom exchange is almost complete

Conclusions and Outlook

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Co-precipitated silica **hinders ferrihydrite transformation**, but **not iron atom exchange**.

This likely affects **mineral stability** against reductive dissolution and **sorption capacity** for trace elements.

We are only showing a **reduced dataset**, since it is not published yet.



Photo 3: Rice paddy field, Chachoengsao, Thailand
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Literature

- [1] Couture, R.-M., et al. (2015). "On–off mobilization of contaminants in soils during redox oscillations." *Environ. Sci. Technol.* 49(5): 3015-3023.
- [2] Cismasu, A. C., et al. (2014). "Properties of impurity-bearing ferrihydrite III. Effects of Si on the structure of 2-line ferrihydrite." *Geochim. Cosmochim. Acta* 133: 168-185.

Acknowledgements

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