Oxidation of Fe(II) in anaerobic groundwater with H_2O_2 for enhanced As(III) co-removal: A field study in Assam (India)

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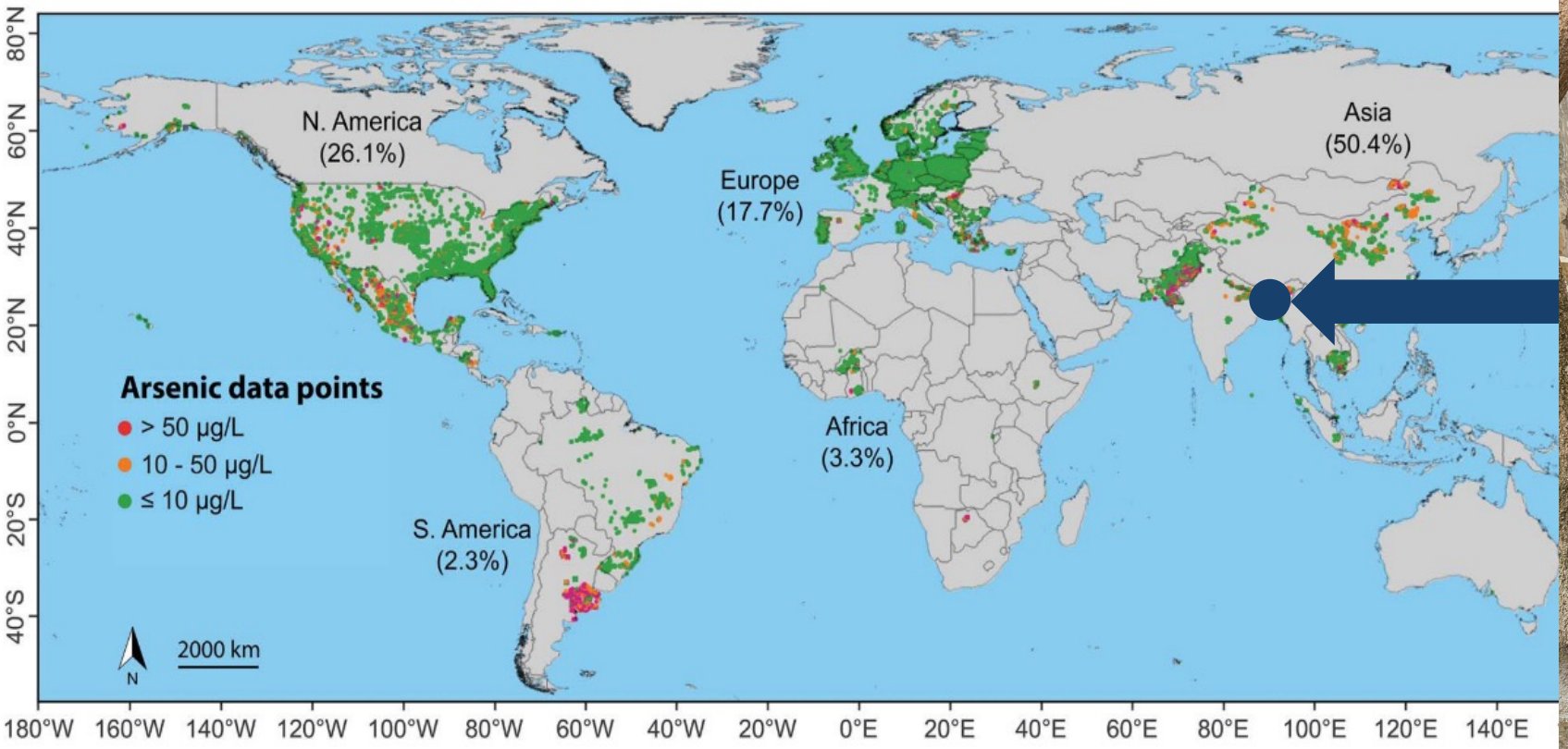
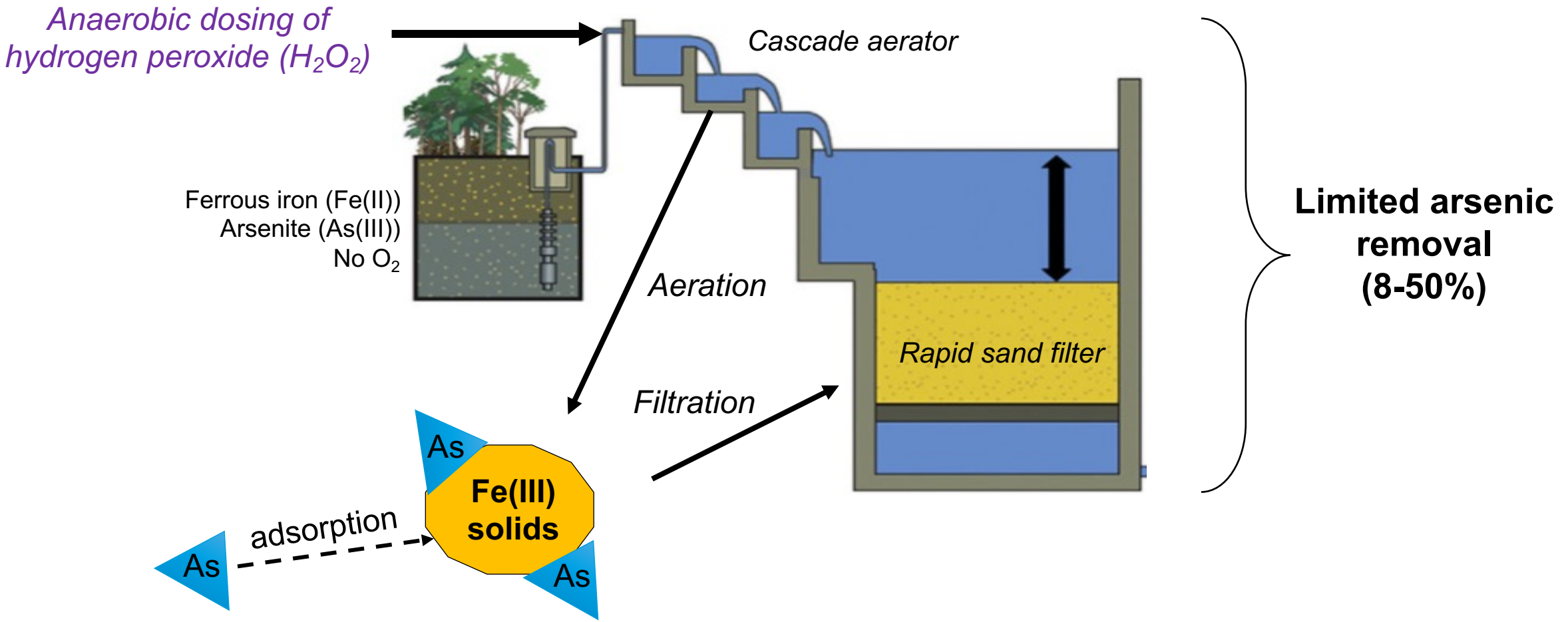
AMSTERDAM INTERNATIONAL WATER WEEK

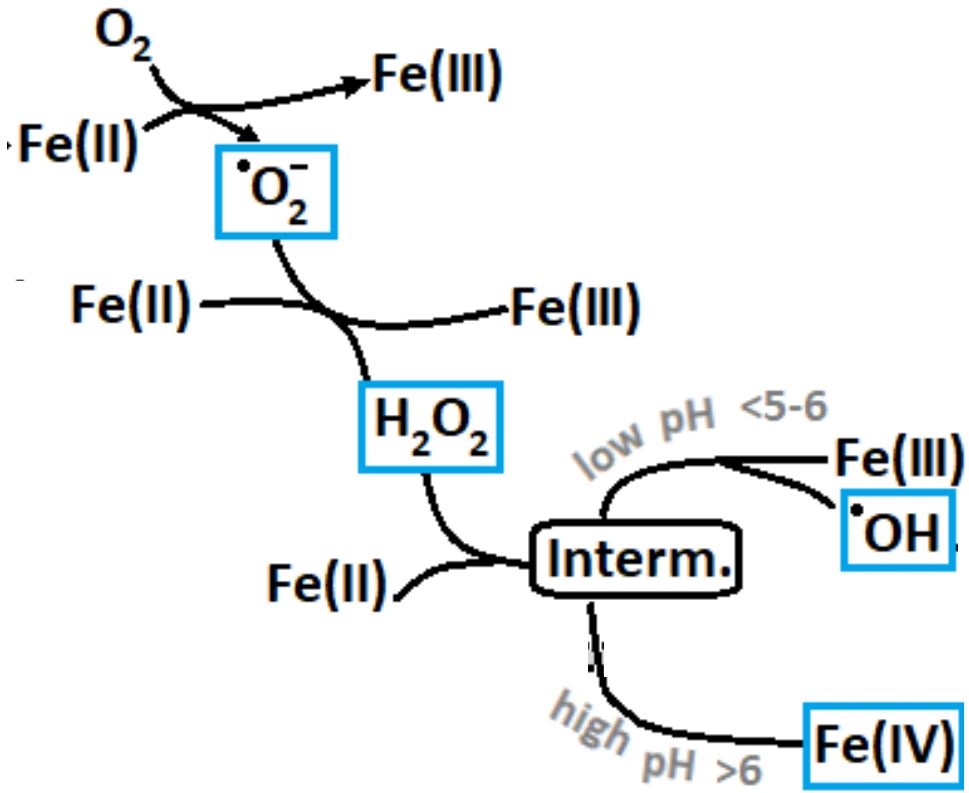
Arsenic in groundwater



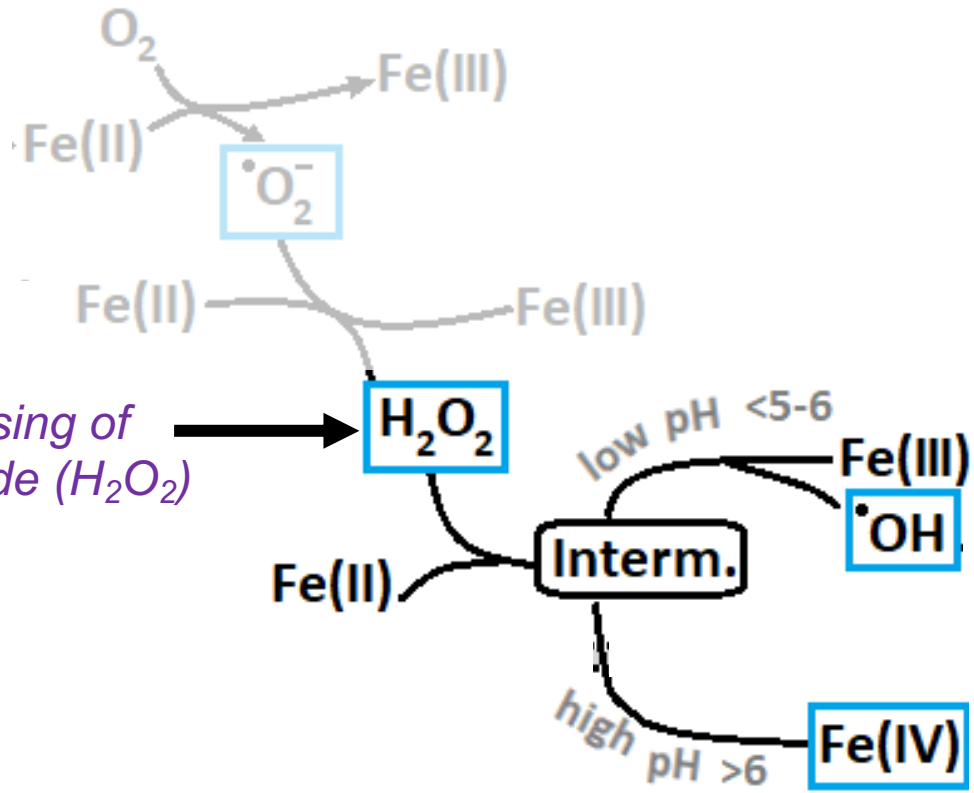
Source: Podgorski and Berg, 2020

Aeration-filtration

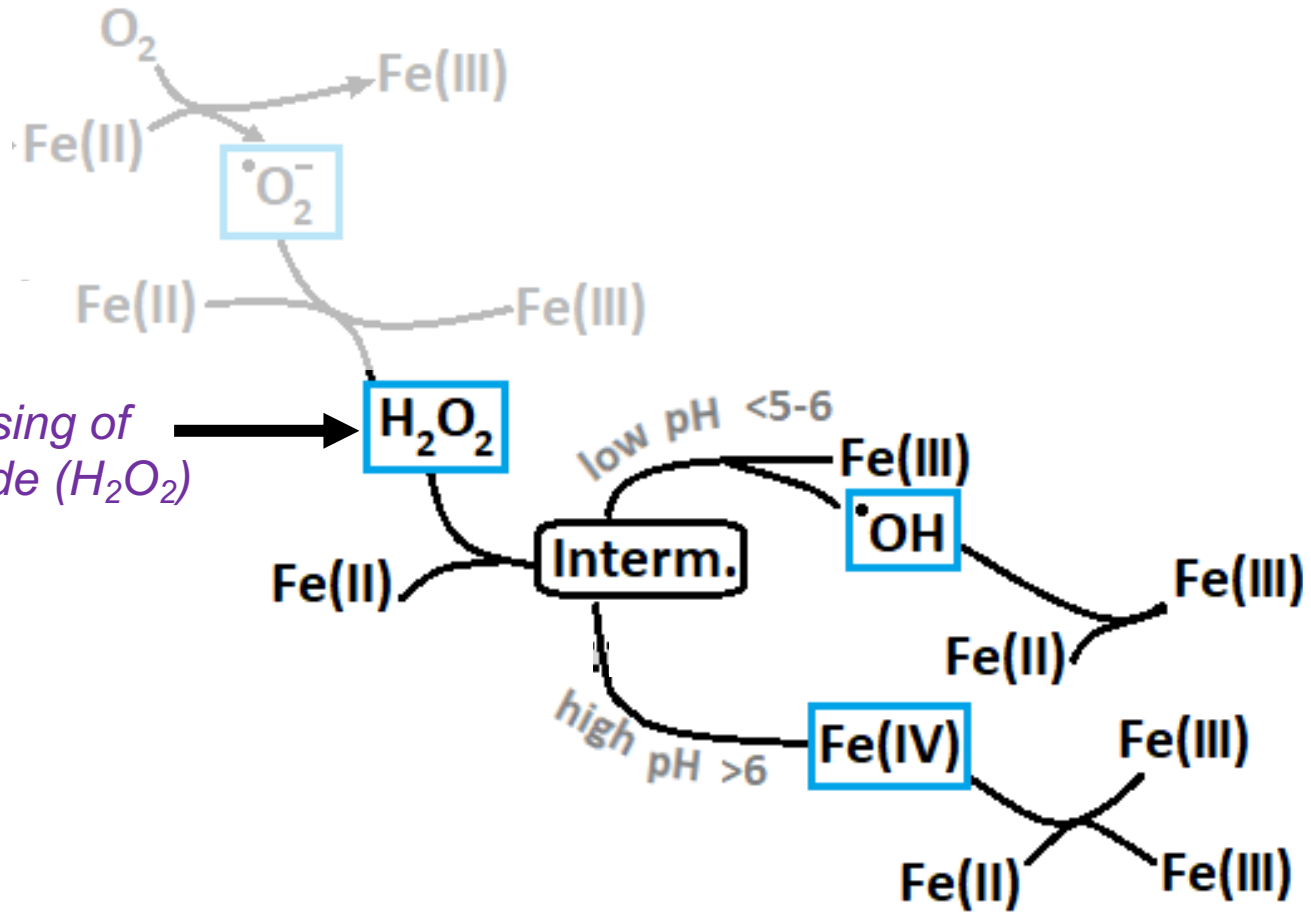



O2
Fe(III)
Fe(II)
•O2−
Fe(II)
Fe(III)
H2O2
low pH <5-6
Fe(III)
•OH
Fe(II)
Interm.
high pH >6
Fe(IV)

Anaerobic dosing of hydrogen peroxide (H_2O_2)



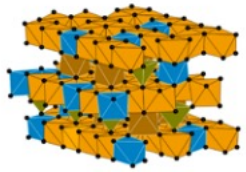
Anaerobic dosing of hydrogen peroxide (H_2O_2)



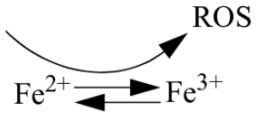
Research question

How does arsenic uptake by precipitating iron change in groundwater when hydrogen peroxide is applied as oxidant compared to dissolved oxygen (aeration)?

Research objectives



Fe(III)-solids minerology

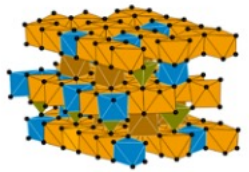


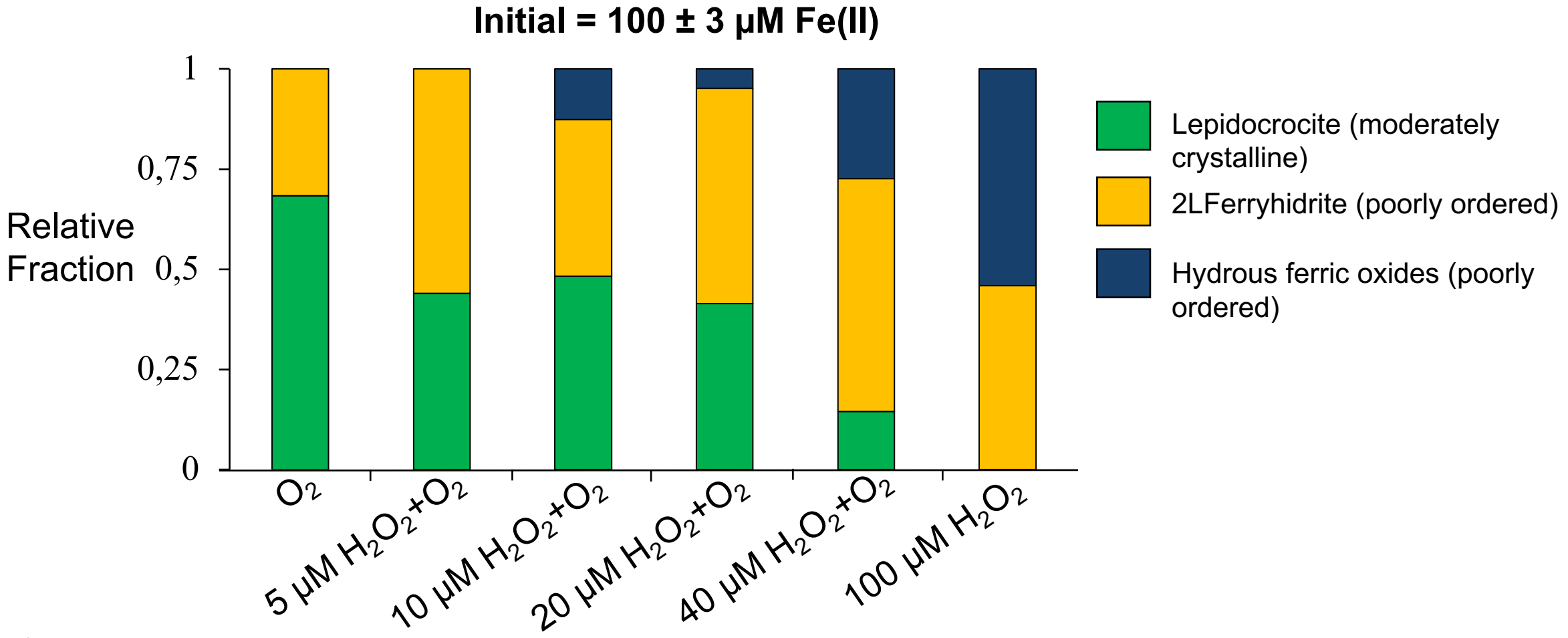
Stoichiometric yield of ROS per mol of oxidized Fe(II) (**ROS:Fe(II)** = **1:1** for **H_2O_2** and **1:3** for **O_2**).

Adsorption of arsenic by Fe(III)-solids

Relevance in various natural groundwater matrices

Fe(III) solids





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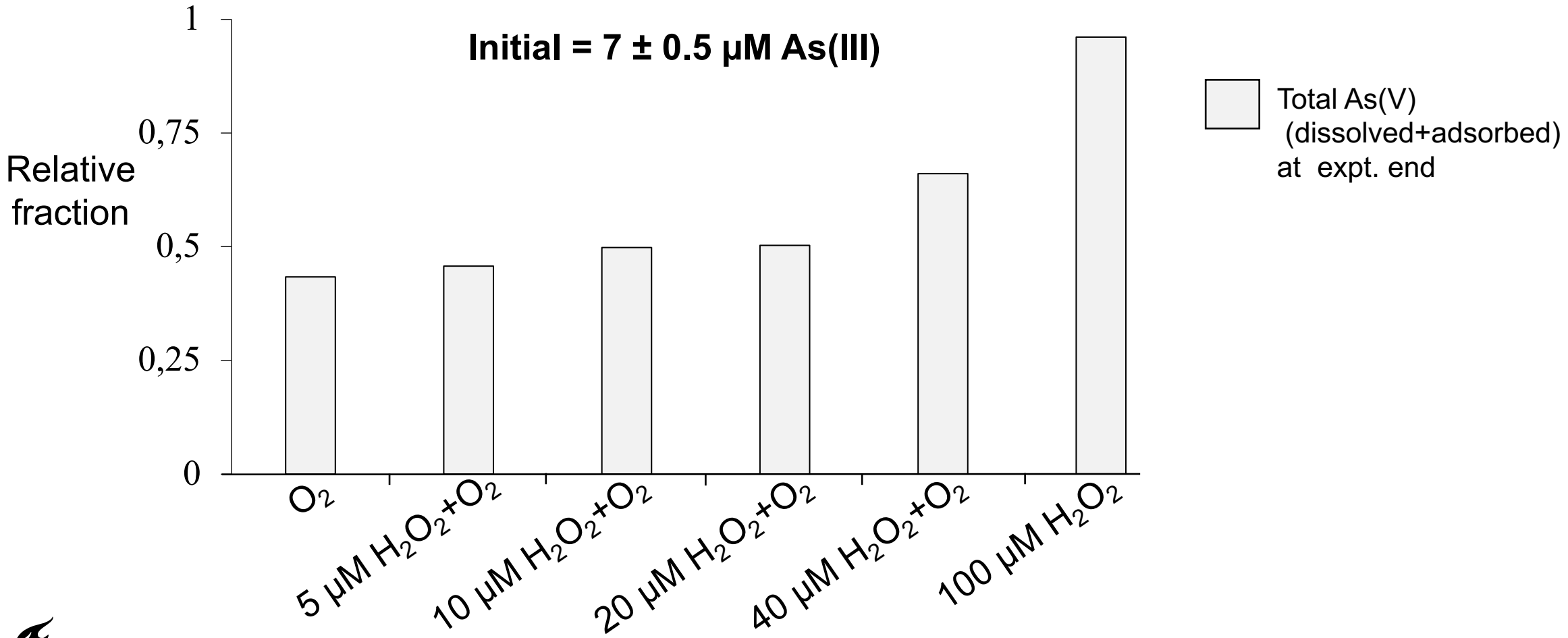
Increase in the fraction of Fe(II) oxidation by H_2O_2, increases the fraction of poorly–ordered Fe(III)-solids.

As(III) oxidation



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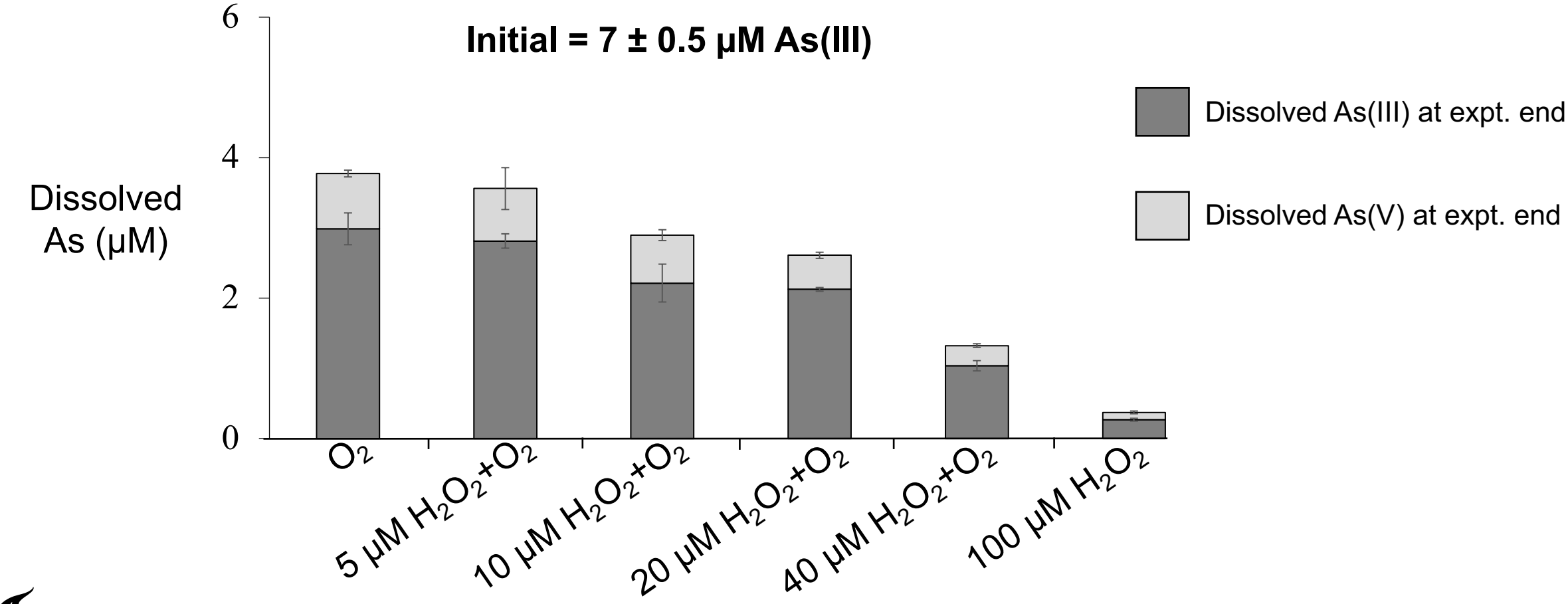
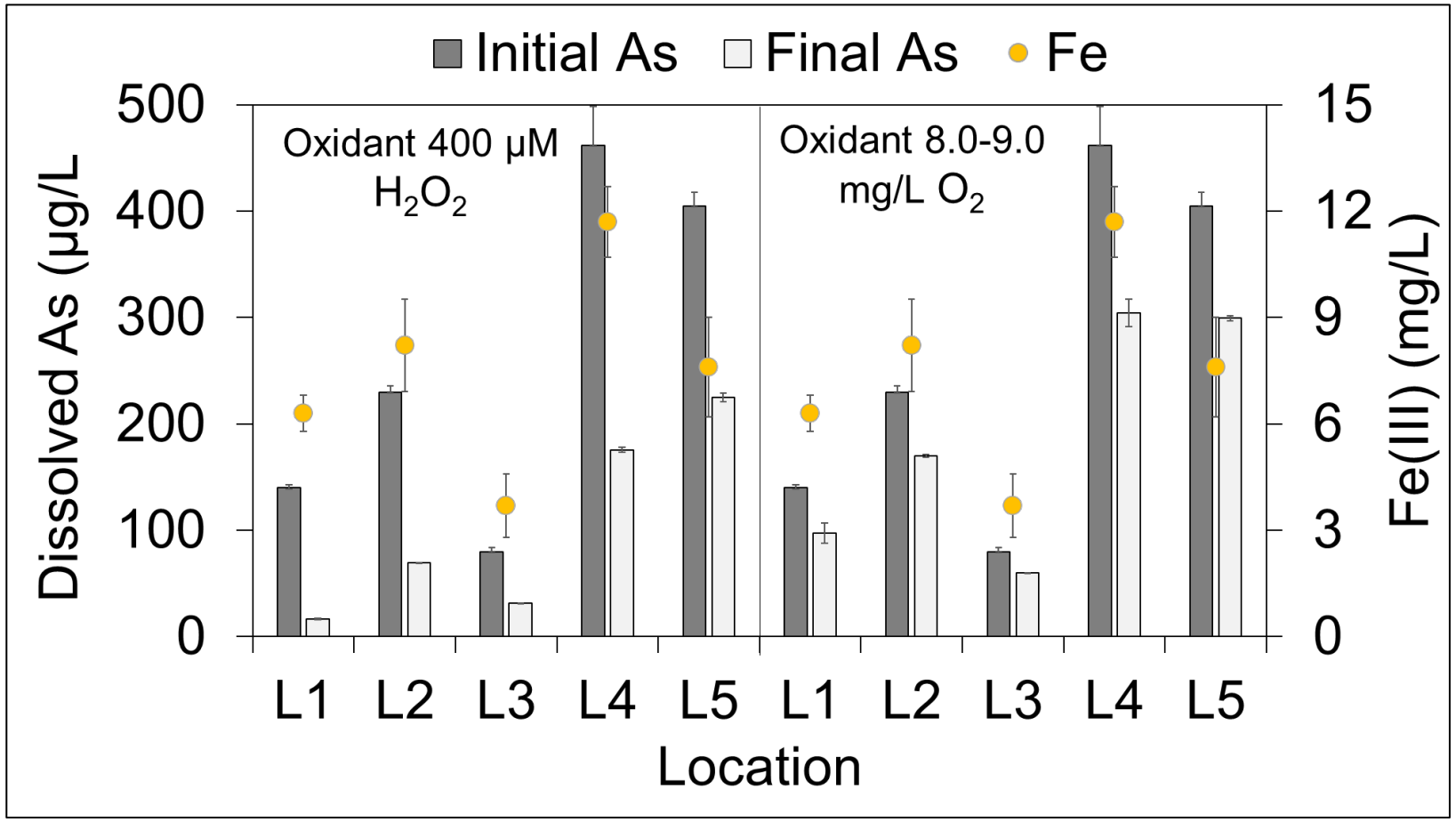
Increase in the fraction of Fe(II) oxidation by H_2O_2, increases the fraction of total As(V) (dissolved+adsorbed).

Arsenic uptake



Increase in the fraction of Fe(II) oxidation by H_2O_2, increases the overall removal of initial As(III).

Natural groundwaters in Assam, India



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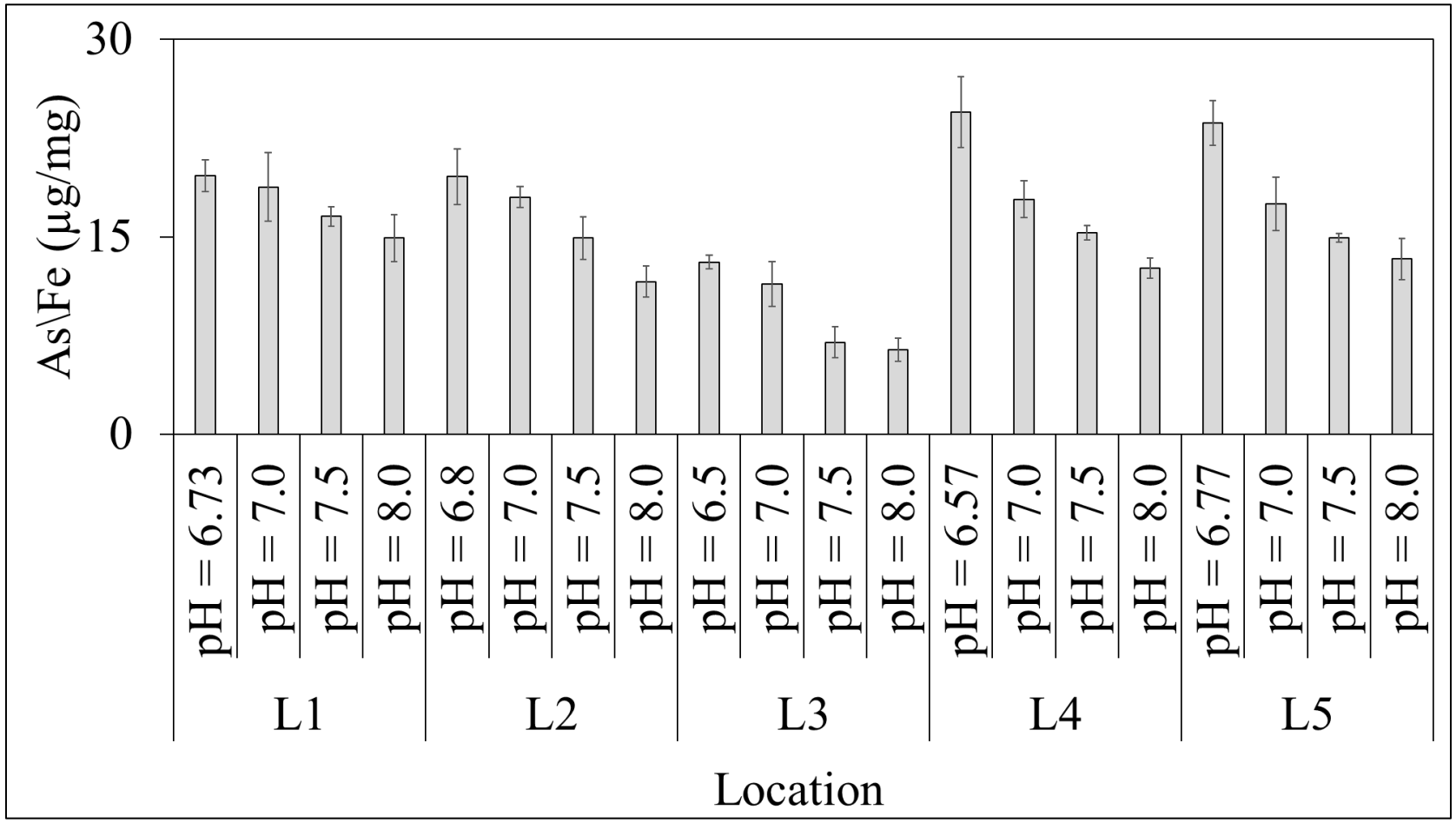
Oxidising groundwater native Fe(II) by H_2O_2 results in better As(III) removal compared to O_2

Added pH advantage!



With increase in pH the As to Fe uptake ratio by the groundwater native-Fe(II) when oxidised with H_2O_2 decreases

Take home message

Oxidising groundwater native-Fe(II) with H_2O_2 is advantageous for As(III) co-removal compared to O_2 due to:

- Poorly crystalline structure of Fe(III) solids
- More favourable stochiometric yield of ROS
- pH advantage when aeration is avoided

→ Results reproduceable in natural groundwater matrices.

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Water
for Impact