ARPHA Conference Abstracts 6: e109448
doi: 10.3897/aca.6.e109448

Conference Abstract

Microbial reduction of synthetic Biogenic Iron Oxides containing various amounts of Organic Carbon and Silica

Daniela Quintero‡, Danielle Fortin‡

‡ University of Ottawa, Department of Earth and Environmental Sciences, Faculty of Science, Ottawa, Canada

Corresponding author: Daniela Quintero (dquin020@uottawa.ca)

Received: 12 Jul 2023 | Published: 17 Oct 2023

Citation: Quintero D, Fortin D (2023) Microbial reduction of synthetic Biogenic Iron Oxides containing various amounts of Organic Carbon and Silica. ARPHA Conference Abstracts 6: e109448. https://doi.org/10.3897/aca.6.e109448

Abstract

Iron oxides formed in close association with bacteria are referred to as biogenic minerals (BIOS). Both the organic part of BIOS and the iron oxide particles affect the net surface charge of those iron-organic carbon aggregates and offer reactive sites that can immobilize many soluble contaminants (Warren and Haack 2001) making BIOS a contender in bioremediation technologies. However, before using BIOS in bioremediation, it is essential to understand the interactions of impurities such as organic matter and other minor components (including silica) (Dyer et al. 2010). This project involves the synthesis of Biogenic Iron Oxides (BIOS) using various silica contents and different soluble alginate concentrations (as an analogue for bacterial exopolysaccharides) close to natural environmental conditions. The mineralogical, chemical and physical composition of the synthesized samples was determined by X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Field Emission Scanning Electron Microscopy (FESEM), Fourier-transform Infrared Spectroscopy (FTIR), and with a Malvern Zetasizer Nano instrument. The various samples (mainly ferrihydrite) were then reduced in the presence of *Shewanella putrefaciens* CN32, a well-known iron reducing bacterium. All microbial reduction experiments (see Table 1) with different types of BIOS were performed under anoxic conditions.

Table 1.

Percentage of the reduced Fe and linear reduction rates for BIOS containing different molar ratios of organic matter and silica to Fe(III) in hydrous Fe oxides (HFO).

Sample	Maximum Fe Reduced (%) /day	Reduction Rate (day^{-1})	R^2
HFO	1.9	0.026±0.005	0.998
Alginate HFO 0.03	2.29	0.027±0.001	0.953
Alginate HFO 0.04	**4.18**	**0.037 ±0.005**	**0.953**
Alginate HFO 0.05	2.14	0.016±0.001	0.970
Alginate HFO 0.06	1.26	0.016±0.002	0.967
Silicate HFO 0.001	2.2	0.028±0.003	0.963
Silicate HFO 0.005	2.9	0.021±0.002	0.950
Silicate HFO 0.01	1.2	0.014±0.001	0.985
Silicate HFO 0.05	**2.8**	**0.047±0.006**	**0.949**
Silicate HFO 0.1	**4.5**	**0.026±0.003**	**0.946**
Alginate 0.03 + Silica 0.05 HFO	**3.95**	**0.048 ±0.005**	**0.977**
Alginate 0.03+ Silica 0.001 HFO	3.8	0.030±0.002	0.982
Alginate 0.03+ Silica 0.005 HFO	**4.5**	**0.028 ± 0.003**	**0.951**
Alginate 0.03+ Silica 0.1 HFO	**4.7**	**0.047±0.001**	**0.998**

Results indicate that the ratio of organic matter and silica to Fe (III) in BIOS affects the reduction rate. It is proposed that alginate binds to iron oxide particles and protects them from reduction. However, samples in presence of high concentration of silica (i.e.,> 0.05) showed structural disorder which likely prevented nucleation of well ordered ferrihydrite, which in return increased their rate of reduction. In addition, higher reduction rates of ferrihydrite were reported at higher concentrations of silica in BIOS, even in the presence of alginate.

Keywords

Ferrihydrite, Alginate, Silicate, coprecipitation, Reduction, *Shewanella* CN32

Presenting author

Daniela Quintero

Presented at

Oral Presentation, Part 4: Emerging Tools & Areas of Scientific Inquiry. Theme: Microbial geochemistry and geomicrobiology. Microbe-mineral interactions

Hosting institution

University of Ottawa

Conflicts of interest

The authors have declared that no competing interests exist.

References

- Dyer L, Fawell P, Newman OM, Richmond W (2010) Synthesis and characterisation of ferrihydrite/silica co-precipitates. Journal of Colloid and Interface Science 348 (1): 65-70. https://doi.org/10.1016/j.jcis.2010.03.056
- Warren L, Haack E (2001) Biogeochemical controls on metal behaviour in freshwater environments. Earth-Science Reviews 54 (4): 261-320. https://doi.org/10.1016/S0012-8252(01)00032-0