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Seasonal changes of silicate's distribution in lake sediments

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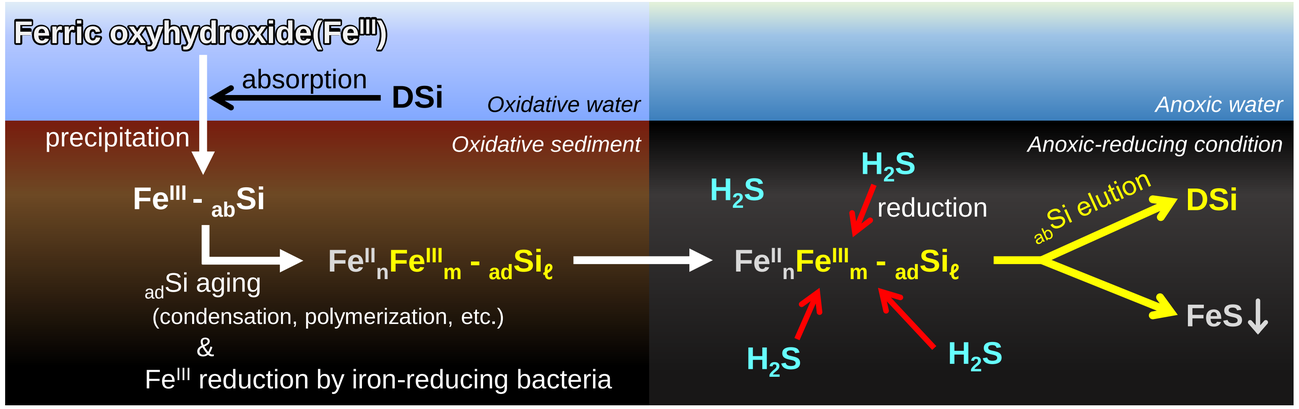
Introduction

What is the anoxic elution process of DSi in lake sediments?



Seasonal increases in dissolved silicate (DSi) in the lake bottom environment were observed with an increase of hydrogen sulfide (H_2S). The DSi are readily adsorbed onto ferric oxyhydroxide and precipitates in an oxidative environment. In this study, we focused on the behavior of ferric oxyhydroxide adsorbing silicates ($_{ad}Si$) in sediment and determined that H_2S was the main cause of anoxic DSi elution because H_2S produced via microbiological processes in the anoxic-reducing environment[1)].

DSi in natural waters

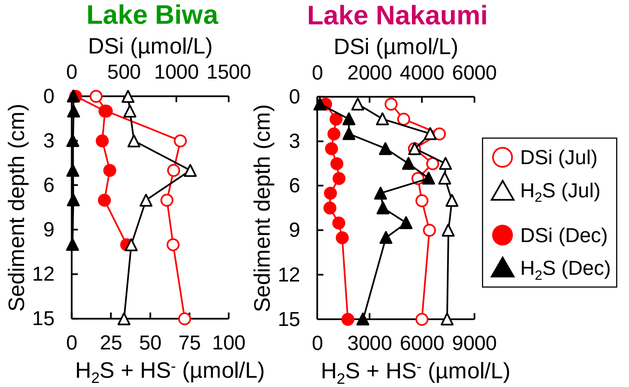
River : 50 ~ 250 µmol/L
Lake : 20 ~ 50 µmol/L
Ocean : 40 ~ 360 µmol/L

The DSi concentrations in natural waters are **less than 1.42×10^3 µmol/L** (solubility of monomeric silicate at 15 ℃[2)])

In general, DSi concentration in natural water can not exceed 1.42×10^3 µmol/L. However, in the lake sediment environment, we found that DSi concentrations in the pore water were easily exceeded 1.42×10^3 µmol/L.

Methods & Results

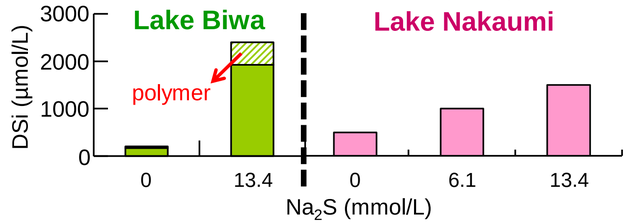
DSi distributions in lake sediments



1. H_2S affects the increase of DSi concentration.
2. In Lake Nakaumi of July, the DSi concentrations exceed 1.42×10^3 µmol/L.

Elution of DSi by Na_2S

Surface sediment + Na_2S (pH 7)
--- 10 min in anoxic condition ---> DSi analysis in filtrate



1. The amount of DSi eluted by Na_2S was higher in Lake Biwa than in Lake Nakaumi.
2. The polymer was confirmed in the eluted DSi.

Conclusions

① The changes in H_2S concentration play an important role in the anoxic elution process of DSi, even if the lake bottom maintains anoxic throughout the year.

② It was found that the DSi at a concentration far exceeding the solubility of monomers was eluted by H_2S in the sediments of Lake Nakaumi, a brackish lake.

③ In Lake Biwa (a freshwater lake), DSi in the pore water showed less than solubility, but the $_{ad}Si$ content was more than twice that of brackish lakes.
Because the formation of ferric oxyhydroxide and the adsorption of DSi are easier than in brackish lakes due to the characteristics of freshwater lakes that repeat the circulation and stratification periods.

References

1) Park et al., 2020. Mechanism of silicate elution by hydrogen sulfide from bottom sediment in a brackish lake. Limnology 21, 197-205.
2) Zuhl et al., 2013. Solution chemistry impact on silica polymerization by inhibitors, In: Amjad, Z. (ed.), Mineral Scales in Biological and Industrial Systems. CRC press, 173-200.