Modeling a rise of atmospheric oxygen induced by Paleoproterozoic snowball Earth event

MARIKO HARADA[1*], EIICHI TAJIKA[2], AND YASUHITO SEKINE[2]

[1]University of Tokyo, Earth and Planetary Science, Tokyo, Japan, harada@astrobio.k.u-tokyo.ac.jp
[2]University of Tokyo, Complexity Science and Engneering, Chiba, Japan

Recent geological studies suggest that Paleoproterozoic snowball glaciations may have possibly caused a rise in atmospheric oxygen [1,2]. The hypothesis is that a global warming in a glacial aftermath enhances chemical weathering on land and provides nutrients to the ocean, which leads to a cyanobacterial bloom [2]. In order to verify the hypothesized oxidation process quantitatively, we developed a simple atmosphere-ocean biogeochemical cycle model and simulated the atmosphere and ocean perterbation after deglaciation.

We set an initial condition under high atmospheric $p\mathrm{CO_2}$ (~0.7 atm), assuming a situation immediately after the Paleoproterozoic snowball deglaciation. Chemical weathering rate is given as a function of temperature and atmospheric $p\mathrm{CO_2}$, mutipled by weahtering efficiency f (f = 1 at present) which depends on soil biological activity and continental area at the time. Nutrient supply is represented by riverine phosphorous input via chemical weathering, which is assumed to be consumed fully by photosenthesis. For the global oxygen cycle, we adopt a redox system model given by Goldblatt et al. (2006) [3].

Our results indicate that, immidiately after the deglaciatoin, global temterature rises as high as 330 K, resulting in extremely high levels of riverine phosphorous input due to the enhanced chemical weathering (~10–20 times higher than that of today). Assuming all the provided phosphorous are consumed by oxygen-producing photosenthesis via cyanobacteria, total amount of oxygen generated by photosenthesis may reach 10^{23} mol during 10^5 years immediately after the deglaciation. Atmospheric oxygen level rises from less than 10^{-5} PAL (present atmospheric level) to ~1 PAL during the first 5 million years, and then gradually decreases to a stable level of ~0.01 PAL. In this model, oxygen concentration rises up to ~0.1 PAL in the first 100 years, probably because of a large perterbation induced by glaciation and subsequent suppression of methane oxidation, which is a major sink of oxygen, by ozone layer formation. However in reality, such an extremely rapid rise in productivity and O_2 level might have been dampened, considering timescale needed for cycnobacteria to recover after the severe glaciation or phosphous adsorption into iron oxides in the shallow ocean. We will therefore also discuss influences of iron-manganese cycles which couple to the phosporus cycle, as well as variations of marine carbon isotopic composition.

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Spectrophotometric analysis for As(V) sorption mechanism in the aluminum hydroxide coprecipitation method

D. HARAGUCHI[1*], C. TOKORO[2] AND S. OWADA[2]

[1]Waseda university, Tokyo, Japan, d.haraguchi@aoni.waseda.jp
[2]Waseda university, Tokyo, Japan, tokoro@waseda.jp
[3]Waseda university, Tokyo, Japan, owadas@waseda.jp

Hydroxide coprecipitation method is widely used in a treatment of wastewater containing dilute toxic anions. But now detail mechanism or quantitative characteristic is not well understood and also demanded. This study discussed a sorption mechanism of dulute arsenic (As(V)) in wastewater using aluminum hydroxide coprecipitation method by analyzing filtrates and precipitates for an artificial wastewater.

Sorption mechanism of As(V) coprecipitation with aluminum hydroxide was investigated using four kinds of experimental methods: (i) sorption instherm formation, (ii) zeta potential mesurement, (iii) XRD analysis, and (iv) FT-IR analysis. We compared between coprecipitation experimental results and simle adsorption ones in which As(V) was just adsorbed on the sysnthized aluminum hydroxide.

In the only coprecipitation experiments, sorption isotherms of As(V) on aluminum hydroxide exhibited a BET type isotherms and sorption densities abruptly increased when the initial As/Al molar ratio was more than 1.5. And zeta potential hardly changed even if sorption densities increased when the initial As/Al molar ratio was more than 1.5. Moreover, the results of XRD and FT-IR analysis represented that patterns and spectra were similar to not the ones of amorphous aluminum hydroxide but amorphous aluminum arsenate when the initial As/Al molar ratio was more than 1.5. On the other hand, these unique tends was not shown in the adsorption experiments [1].

Thus, the inherent phenomena which can sorb more As(V) than single layer adsorption has occurred in the only coprecipitation experiments. The results of XRD and FT-IR analysis suggested that the precipitates have changed depending on the initial As/Al molar ratio and a surface precipitation such as amorphous aluminum arsenate was formed when the initial As/Al molar ratio was more than 1.5, whereas simple tow-dimentional adsorption of As(V) onto the surface of aluminum hydroxide when the initial As/Al molar ratio was less than 1.5. These trends were qualitatively accorded with sorption mechanism of dilute As(V) with ferrihydrite [2].

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