Mineral dissolution apparatus under anoxic conditions and dissolution kinetics of biotites

H. SUGIMORI, T. YOKOYAMA AND T. MURAKAMI

Department of Earth and Planetary Science, The University of Tokyo, Tokyo, Japan (sugi@gbs.eps.s.u-tokyo.ac.jp, yokoyama@gbs.eps.s.u-tokyo.ac.jp, murakami@eps.s u-tokyo.ac.jp)

Mineral-water-atmosphere interactions under anoxic conditions are not well known although they are important for better understandings of atmospheric evolution in the Precambrian and modern weathering deep in the subsurface. An apparatus that enables us to carry out mineral dissolution experiments under anoxic conditions was developed to examine the effects of dissolved oxygen on dissolution rates and kinetics. With the apparatus, dissolution experiments of biotites were carried out. The results were compared with those obtained by similar dissolution expriments under the present atmospehre, i.e., oxic condition.

The experiments were done in a glove box where dissolved O_2 (DO) was less than 0.001 mg/l that was equivalent to 3 x 10^{-5} atm of P_{O2} (Fig. 1). The eluent solution was bubbled by Ar gas before and during the experiments. The dissolution experiments were started after the concentration of DO was less than 0.001 mg/l. The concentration of DO was monitored and less than 0.001 mg/l during the experiments. The eluent solution was prepared with hydrochloric acid at pH3 and provided to the sample chambers at a rate of 30 ml/day. The experimental temperature was 40 ˚C and the duration was 30 days.

The dissolution rate was slightly faster under the anoxic condition than the oxic condition (Fig. 2). The dissolution was almost stoichiometric both under the anoxic condition than the oxic conditions. Dissolution experiments at pH 6 is now under way.

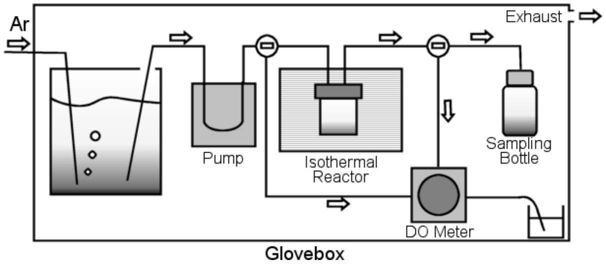

Fig. 1. Schematic diagram of experimental apparatus.

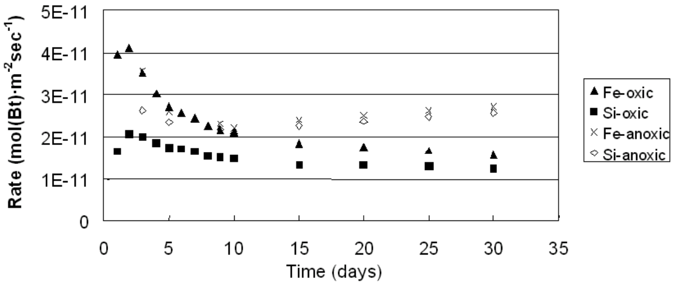

Fig. 2. Comparison of dissolution rates of biotite between anoxic and oxic conditions.

Isotopic composition of methane reflecting a condition of microbial system

A. SUGIMOTO

Center for Ecological Research, Kyoto University, Otsu, Japan (atsukos@ecology.kyoto-u.ac.jp)

Methane is usually produced in a microbial community in natural ecosystem in which various materials are transferred from producer to consumer. Substrates for CH_4 production such as CO_2, H_2, and acetate are also produced in the system, and consumed by methane producing bacteria. Hydrogen is a typical material transferred from producer to consumer, known as "interspecies-transfer", which usually means that H_2 is transferred directly from bacteria to symbiotic methanogen without leaking into the environment. In natural ecosystem, however, condition of transfer may be variable from tightly symbiotic to free living condition. The isotopic composition of methane produced in the system, therefore, reflects the condition of the system, which may control the isotopic composition of substrate and apparent fractionation factor.

Observation on the isotopic composition of various form of methane was made at Mizorogaike pond on a floating mat of sphagnum peat. Hydrogen concentration in bubble was measured as well. The $\delta^{13}C$ of bubble CH_4 showed large variation: most data ranged from -70 to -48‰. Bubble CH_4 taken at 40cm had lower $\delta^{13}C$ than that taken at 10cm, and seasonal variation with higher value during summer was also observed. The δD of bubble methane during summer mostly ranged from -320 to -370‰. This range roughly agrees with the δD value expected from the δD_{water}- δD_{CH4} relationship by Sugimoto and Wada (1995), as the δD of porewater mostly ranged from -45 to -20‰, excluding surface water.

Hydrogen concentration in the bubble increased up to 173ppm in the beginning of summer, suggesting H_2 leaking from the system. Hydrogen concentration in the site of CH_4 production may affect on the hydrogen fractionation during methane production (Burk, 1993; Sugimoto and Wada, 1995).

It has been known that carbon isotope fractionation between methane and CO_2 is variable. This might be also caused by a variation in the condition of the bacterial community.

References

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