Sorption of Co^{2+} to biogenic Mn oxides produced by MnO_4^- reduction

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Introduction

Various radionuclides such as $^{137, 134}Cs$, ^{90}Sr and ^{60}Co were released to sea during the accident of the Fukushima Daiichi nuclear power plant. For decontamination of pulluted seawater, we need to establich the techniques for eliminating such radionuclides from seawater, where cations like Na^+ and Ca^{2+} of high concentrations can strongly interfere.

Mn oxides, particulary biogenic Mn oxides (BMOs) are known to sorb various metal ions [1, 2]. BMOs have been produced by oxidation of Mn^{2+}. They can be also produced by reduction of MnO_4^- [3]. Nevertheless, there are little information on the formation pathways and metal uptake mechanisms of the latter. In this research, we have demonstrated the production of BMOs from MnO_4^- with *Pseudomonas fluorescens* and the sorption of Co^{2+} to the BMOs.

Experimental

BMOs ware produced by reduction of $KMnO_4$ with *P. fluorescens* and collected by centrifugation. After washing, the BMOs were re-suspended in 40 mL of 0.1 M NaCl containing 4 mg/L $CoCl_2$. The concentrations of Mn and Co in the aqueous phase were determined by ICP-OES after filtration. The concentrations of MnO_4^- in the solution were determined by UV/Vs spectroscopy. Oxidation states of Mn and Co in BMOs were characterized by X-ray absorption near edge structure (XANES) analysis.

Discussion of Results

BMOs were rapidly precipitated by the exposure of MnO_4^- to the microbial cells within 2 h. A part of BMOs was further reducd to Mn^{2+} and/or Mn^{3+} and dissoved after 21 h when the cell concentration was high. Amounts of the sorbed Co^{2+} by the BMOs was higher than that by the abiotical Mn oxide produced by reduction with lactate and was acompanied with release of Mn^{2+} and/or Mn^{3+}. XANES analyis showed that a majority of thr sorbed Co^{2+} was oxidized to Co^{3+} in the BMOs, which indicate that coupled redox reactions of Co^{2+} and Mn^{4+} can derive the sorption of Co^{2+} to BMOs.

[1] Suarez DL. *et al*. (1976) *Geochim. Cosmochim. Acta* **40**, 589-598. [2] Yu Q *et al*. (2013) *Geomicrobiol. J*. **30**, 829-839. [3] Lei L *et al*. (2014) *Environ. Sci. Technol* **48**, 2885-2892.