Nanometer-scale observation of bacteria-mineral interface by TEM-EDS

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Introduction

A bacterium, a single cell microorganim, is widely distributed over the Earth's surface. In the last two decades, the interaction between bacteria and mineral surface has been enthusiastically studied [1-4]. Some researches clearly showed that bacteria profoundly affect the process of silicate mineral weathering by produced organic compounds such as organic acids and polysaccharides [3, 4]. However, the process on the cell-mineral interface is still unknown in detail, because the interaction actually occurs on the nanometer scale. In the study, we investigated the bacteria-mineral interactions by using the laboratory incubation experiments and Field-Emission Transmission Electron Microscope (TEM) equipped with Energy Dispersive X-ray Spectroscopy (EDS).

Materials and Method

Bacteria were isolated from organic rich soil in the University of Tsukuba. The bacteria and 200 mg of crushed albite grains were added to a glass test tube containing 20 ml of sterilized liquid medium (1.5 g glucose, 1.0 g NH_4Cl, 0.06 g K_2HPO_4, 0.02 g $MgSO_4{\cdot}7H_2O$, 0.002 g $FeSO_4{\cdot}7H_2O$, 0.002 g $MnSO_4{\cdot}4\text{-}6H_2O$, 0.1 g hipolypepton, and 100 ml Elix water). The test tube was shaken on a reciprocal shaker for various time intervals at 28 °C. A cross-section at the interface between bacteria and albite was made by JEOL JEM-9320FIB Focused Ion Beam (FIB) system. TEM observation and EDS analysis were performed using JEOL JEM-2100F electron microscope.

Results and Discussion

After 14 days incubation, the extracellular polymeric substances (EPS) produced by bacteria were spread at the boundary between bacterial cell and albite surface. TEM and EDS analyses of the cross-section at the interface revealed that aluminosilicate is reprecipitated over the bacterial cell with a thickness of less than 100 nm, which is ascribed to the Al and Si cations dissolved from the albite. Many kinds of amorphous aluminosilicates were already observed on the bacteria in volcanic ash [5]. Therefore, there is a high possibility that the aluminosilicate observed in the study can be readily precipitated as an amorphous by the bacterial activity.

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