Bacterial induced mineralization in the weathered sediments

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Introduction

Bacteria are widely distributed in various weathered rocks and sediments on the Earth surfaces. Recently, it has been shown that these bacteria have strong impacts on mineral formation by interaction of their cell surfaces with dissolved ions in pore waters. In this study, we investigated that the effects of bacteria on the formation of silicate minerals in a weathered pyroclastic deposit, southern Kyushu, Japan. Results of this study suggest that the formation of secondary minerals has been apparently promoted by the bacterial interaction.

Materials and methods

Weathered pyroclastic deposit (6,400 YBP) distributed around southern Kyushu, Japan was used in this study. The pyroclastic deposit consists of fine to coarse rhyolitic volcanic glass fragments with great amounts of allophane produced during weathering processes. To investigate bacterial mineralization in this deposit, we performed X-ray diffraction analysis (XRD), transmission electron microscopy (TEM), and energy dispersive X-ray analysis (EDX) for secondary products including biogenic and non-biogenic products. The pore water in the deposit was extracted by high presser press method, and then chemical analysis and geochemical calculation were also done to evaluate saturation states.

Results and conclusions

TEM indicated that the pyroclastic deposit contains allophane as a non-biogenic secondary product with the Al/Si and Fe/Si ratios are 1.76 and 0.20, respectively. Additionally, a great number of spherical to rod-shaped bacteria covered or decorated by biogenic poorly ordered silicate minerals with a thickness <1.0_m was also present. EDX revealed that the biogenic minerals consist mainly of Al and Si (Al/Si = 0.6 to 1.5), and variable amounts of Fe (Fe/Si = 0.04 to 1.4) corresponding to the chemical compositions between proto-halloysite allophane and chamosite. Thus, the biogenic minerals in this weathering environment have different chemical characteristics from those of the non-biogenic minerals, and are possibly present as early metastable phases of the non-biogenic allophane.

References

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Petrography and Petrology of Torul and Sarihan Plutons, the Eastern Pontides, NE Turkey

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The Eastern Pontides, display distinct magmatic arc origin, is divided into two geologically different zones as northern and southern. Although granitoidic intrusions are seen in the both zones, they are most abundant in the northern zone. We present petrographical and geochemical data for Cretaceous aged Torul and Sarihan Plutons in the northern zone and southern zone, respectively.

The ellipsoidal Sarihan Pluton (66±2 Ma) covers an area of approximately 40 km^2 and made up from quartz-monzodiorite, granodiorite and quartz-diorite. The rocks show medium-grained, poikilitic, monzonitic, anti-rapakivi and myrmekitic textures. The Torul Granitoid (72±2 Ma) is compressed ellipse shaped and approximately 15 km's length and 3 km's width. The pluton is composite zoned and consist of quartz-diorite, granodiorite, monzogranite, quartz-monzonite, quartz monzodiorite and siyenogranite. _t shows holocrystaline, subothomorph, fine-medium grained, porfiric, monzonitic, poikilitic, myrmekitic and micrographic textures. The Sarihan Granitoids contain 65.6 to 75.9 wt% SiO_2 and the Torul samples yield 52.2 to 73.5 % SiO_2 . The Torul samples contain, on average, more FeO_{tot}, MgO, TiO_2, P_2O_5, Al_2O_3, and CaO than the Sarihan samples. As the K/Na ratios of Sarihan Granitoid range 0.4 to 0.7, the K/Na range of the Torul samples are 0.3 to 1.4. All of the Sarihan and Torul Granitoid samples are subalkalic and calc-alkaline. The Sarihan Granitoids yield lower values and less variation in $FeO_{tot}/(FeO_{tot}+MgO)$ than the Cretaceous granitoids. Overall, the Sarihan samples are somewhat more aluminous in character than the Torul Granitoids. Rb varies in both suites from ~50 to 250 ppm, Sr concentrations from Sarihan Granitoids are more variable and span a somewhat larger range than Torul Granitoids. LIL enrichment is clearly seen ORG normalized trace element compositions of the Sarihan and Torul Granitoids. Chondrite normalized rare patterns of Torul Granitoids are smooth and moderately enriched in the light REE; $(La/Yb)_N$ ranges from 3.0 to 14.2 and slight Eu anomaly is present. In the tectonic discrimination diagrams both samples fall into volcanic arc granitoid fields.

Emplacements of both plutons are controlled by tectonic direction of NE-SW and NW-SE. Elongation of subduction related magmatic plutonic rocks show good agreement with those of tectonic directions in the Eastern Pontides. Petrographical and chemical features of the both granitoids suggest their origin closely related arc magmatism. While Sarihan Granitoid, emplaced in southern zone, almost the same age with Torul Granitoid, it shows chemically more crustal input.