Experimental Reproduction of Martian Soil by Hydrothermal Alteration of the Synthetic Martian Basalt with Sulfuric acid and CO2

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The formation process of the Martian soil is one of the most essential problems to understand the surface environment of the Mars. Especially, iron minerals in the Martian soil should be the key component to characterize the red planet. The major Martian volcanoes consist of iron-rich basaltic rocks. Volcanic activities of the Martian volcanoes should involve fluid rich in sulfuric components and CO_2. In this study, hydrothermal alteration experiments of the synthetic iron-rich basaltic material with sulfuric acid and CO_2 are conducted to elucidate the soil formation processes on the Martian surface.

Experimental temperatures are 100 to 300 degree C. Acidities of the solutions are pH1.0, 3.0 or 7.0. Run durations are 3 to 16 weeks. Appropriate amount of CO_2 is introduced to the experimental vessels by dry ice or silver oxalate.

Run products of the alteration experiments show characteristic reddish to brown color depending on the acidity and temperature. Major run products of the experiments are iron oxide/hydroxide minerals, cristobalite, quartz and clay minerals. Iron mineral species have distinctive color and Fe/O ration in EDS spectra qualitatively. SEM/EDS and XRD observations also revealed representative iron mineral species in the run products. Morphology of the iron minerals produced at 100 and 150 degree C were characteristic granular to spheroidal shape with diameters of 0.5 to 3 micron meters.

Acidic hydrothermal alteration may have essential role to form the Martian soil which is rich in iron oxide. Especially, iron mineral species and morphology strongly depend on temperatures and acidities of the hydrothermal fluid. Direct observation of the Martian soil may provide us information on the conditions of hydrothermal alteration related to the Martian volcanic activities.