IR spectroscopic study of amino acid adsorption properties on amorphous silica surface

Norio Kitadai[1]; Tadashi Yokoyama[2]; Satoru Nakashima[3]

[1] Earth and Space Science, Oosaka Univ.; [2] Dept. Earth and Space Science, Univ. Osaka; [3] Dept. Earth & Space Sci., Osaka Univ.

Peptide formation is an essential process in the chemical evolution to life. The importance of mineral surfaces for amino acid polymerization has been widely discussed by a number of experimental investigations. However, there are little studies about interaction mechanisms between amino acids and mineral surfaces during adsorption or thermal condensation.

Infrared (IR) measurements allow ones to investigate the dissociation states of amino acids adsorbing on mineral surfaces. Transmission and diffuse reflectance spectroscopy are mainly utilized to investigate amino acid-mineral interaction. However, these techniques are limited by several problems such that sample solids must be dried prior to analysis, and overlapping with absorption bands of adsorbed water frequently prevents detailed analysis.

On the other hand, attenuated total reflectance (ATR)-IR spectroscopy could be applied to study surface and interface chemistry of adsorbate in aqueous phases in situ. It is also available to investigate the dissociation state of dissolving amino acid in great detail. So in this study, amino acid adsorption properties on amorphous silica surface were studied by ATR-IR spectroscopy.

At first, pH-induced spectral changes of dissolved amino acids were analyzed to draw the calibration lines to measure the mole fraction of each dissociation state of amino acids. By these calibration lines, it is demonstrated that about 96 % of adsorbed Lysine on amorphous silica surface exists as cationic states, which is clearly different from the dissociation states of dissolved Lysine (50 % Cationic states).

The mechanisms of mineral contribution on amino acid condensation reactions remain unknown, whereas there are many experimental data for catalytic effects of mineral surface for amino acid polymerization. On the other hand, dissociation states of amino acid greatly affect the kinetics and equilibrium of amino acid condensation reaction. So the ATR-IR technique for quantitative determination of the dissociation states of adsorbed amino acid on mineral surface would be useful for understanding the effects of minerals in the chemical evolution.