

Toward the understanding of interfaces controlling mineral-water-organic interactions

Satoru Nakashima[1]; Norio Kitadai[2]; Takahiro Otsuka[1]; Yushi Shushi[3]; Kasumi Sakata[4]; Tadashi Yokoyama[5]

[1] Dept. Earth & Space Sci., Osaka Univ.; [2] Earth and Space Science, Oosaka Univ.; [3] Osaka Univ; [4] Earth and Space, Osaka Univ.; [5] Dept. Earth and Space Science, Univ. Osaka

<http://life.ess.sci.osaka-u.ac.jp/>

Most of dynamic processes at the earth's surface, such as origin and evolution of life, transport of fluids and materials, accumulation of resources, environmental pollution, rock deformation and seismogenesis etc., occur at the mineral-water-organic interfaces. Although many experimental studies have been conducted to investigate these processes, only phenomenological description by determining resultant species concentrations were generally conducted and essential mechanisms remain unsolved. Therefore, in this study, we will insist on 1) the necessity of direct observation of interfacial processes such as adsorption and electron transfer reactions, 2) the possibility of different physicochemical properties of interfacial thin film water than the bulk water, and 3) the possible rate-determining step of the whole processes can often be the diffusion through interfaces or porous structures.

For instance, the chemical evolution steps to life are thermodynamically and kinetically difficult processes and catalytic effects of minerals have been proposed. However, detailed roles of mineral surfaces are not understood. On the other hand, we should predict quantitatively interactions between organic pollutants and soil constituent minerals in the environmental pollution. Therefore, we are now observing adsorption and electron transfer processes between organics (amino and humic acids) and minerals (silica, iron hydroxide and clay minerals) by means of attenuated total reflection (ATR) infrared (IR) spectroscopy. As a result, dissociation states of amino acids adsorbed on minerals are found to be different from those in bulk solutions and might be favorable for peptide formation. We should take into account different structures and properties (eg. entropy) of surface thin film water than the bulk water. Moreover, the rate-determining step of redox processes between iron hydroxide and humic acid can be the diffusion in micro-pores of iron hydroxide. Further developments of analytical methods observing in detail the interfacial reactions and more physicochemical data (viscosity, diffusion coefficient, electrical conductivity, sonic wave velocity and thermodynamic values etc.) on mineral surface thin film water and bound water on organic macromolecules are needed in the future.