# Thermodynamics and kinetics of organic-inorganic interactions

# Satoru Nakashima[1], Dai Shiota[2], Masahiro Ikoma[3], Kiyoshi Nakazawa[4]

[1] Interactive Research Center, Tokyo Inst. Technol., [2] Dept. Earth and Planet. Sci.,TITech, [3] Interactive Research Center of Science, Tokyo Inst. Tech., [4] Earth and Planetary Sci., Tokyo Inst. Tech

http://www.geo.titech.ac.jp/nakashimalab

At the earth's surafce, divers organic-inorganic interactions are occurring and controlling the origin and evolution of life and biogeochemical cycling. However, because of complexity of these interactions and lack of fundamental physicochemical parameters, quantitative treatments have been limited. In this paper, we will review thermodynamics and kinetics of organic-inorganic interactions, and propose two approaches to overcome the above difficulties.

Thermodynamic values such as Gibbs free energy of formation for complex organic molecules are lacking and preventing the evaluation of equilibria of complex interactions. Interaction experiments between these complex organics and inorganic compounds, with known thermodynamic values, will give equilibrium constants. These can be used to determine Gibbs free energy of reaction for organic transformations.

The kinetics of organic transformation in the presence of inorganic compounds have essential problems such as difficulty in evaluating the kinetic parametetrs without knowing side and chain reactions, and effects of environmental parameters (pH, water/rock ratio,..) and of inorganic catalysts. Experiments combined with numerical simulations are necessary to evaluate at least apparent kinetic parameters such as reaction rate constants, activation energies and frequency factors.

By using the above methods, several examples will be given on complex organic-inorganic interactions. One is organic polymerization of amino acids in the presence of amorphous silica, which is proposed here as a possible mechanism for the origin of biopolemers on the early earth. Another example is transformation of organic pollutants on mineral surfaces.