

Geochemical evidence for the provenance of Kosa aerosols in Beijing, Republic of China

T. NAKANO¹, Y. YOKOO², M. NISHIKAWA³, AND H. QUAN⁴

¹ Institute of Geoscience, University of Tsukuba, Tsukuba 305-8572, Japan (nakanot@arsia.geo.tsukuba.ac.jp)

² Department of Environmental and Natural Resource Science, Tokyo University of Agriculture and Technology, Tokyo 183-8509, Japan (yokoo-y@cc.tuat.ac.jp)

³ National Institute for Environmental Studies, Ibaraki 305-0053, Japan (mnishi@nies.go.jp)

⁴ China-Japan Friendship Environmental Protection Centre, Beijing 100029, P.R. China

Recent increase of eolian dust (Kosa) originated from arid areas in northern China has been influencing the atmospheric, terrestrial, and marine environments in the northern Pacific. The impact of Kosa is particularly serious on metropolitan Beijing and surrounding areas, although its provenances remain unsolved. In order to search for the emission areas of the recent Kosa particles on Beijing, we determined the elemental and Sr-Nd isotopic compositions of evaporate minerals dissolved by water and 5% acetic-acid and acid-resistant, detrital minerals for surface soils in northern China. Compilation of present and reported data shows that (1) the detrital minerals in loess and desert sand can be divided based on Sr and Nd isotopic ratios into five areas, northern China (NC), Central Loess Plateau (CLP) including its northern desert, Taklimakan desert (TM), Beijing and its vicinity (BJ), and western Beijing (WBJ), and (2) the evaporate minerals in soils of NC and BJ are distinctly lower ⁸⁷Sr/⁸⁶Sr than those of other southern areas. The isotopic signature indicates that (1) loess is not so uniform as has been considered but is utilized as an index of Kosa, and (2) the Kosa on Beijing is mainly originated from NC and WBJ rather than the CLP constituting about 80% of the Chinese loess. Several soils in BJ changes their elemental and Sr-Nd isotopic compositions to those in WBJ toward surface, showing that the fine-grained minerals of desert sand in WBJ become dominant toward Beijing during its southeastern transportation in the atmosphere. This is consistent with the trajectory of Kosa transportation and the increasing development of desert area in Inner Mongolia.

Energies and time scales for the chemical evolution toward life

S. NAKASHIMA, D. SHIOTA, T. HARAMAKI, AND S. SHIMADA

Interactive Research Center of Science, Tokyo Institute of Technology, Tokyo, Japan. (satoru@geo.titech.ac.jp)

The chemical evolution process from simple molecules to polymers is thermodynamically difficult and need external energy. In order to overcome this difficulty, we propose here a new mechanism of coupled organic-inorganic evolution by using a spontaneous transformation of unstable inorganic materials (minerals) under hydrothermal conditions (Nakashima and Shiota, 2001). Hydrous silica, phosphates and iron hydroxides/sulfides might be candidate mineral "catalysts" to provide thermodynamic free energies to the polymerisation of organic molecules such as amino acids, nucleotides and membranes. We are trying to evaluate both theoretically and experimentally the possible candidate mineral – organic pairs. Because of the lack of thermodynamic data for organic polymerization, we can conduct organic-inorganic pair experiments to evaluate Gibbs free energies of the overall reactions. By subtracting the free energies for inorganic transformation, we can obtain those for organic polymerization.

Given that the polymerization reactions are feasible thermodynamically, then the kinetic constraints should also be taken into consideration. The reaction rates of threonine (Thr) polymerization into membraneous film (possibly polyester) appeared to be faster than the decomposition of Thr into glycine (Gly) at temperatures less than 140 °C (Shiota and Nakashima, 2003). In the above experiments, Gly was then slowly transformed into glycylglycine (GlyGly).

The decomposition rates of GlyGly have been determined by using *in-situ* attenuated total reflection (ATR) infrared (IR) spectroscopy. The GlyGly decomposition was found to be the first order kinetics and the activation energy was about 120 kJ/mol at 140-160 °C. The peptide formation rate should be faster than the above peptide decomposition rate to be effective in the chemical evolution.

Some interaction experiments have also been conducted on phosphates-adenine/adenosine systems. Although no interactions were observed in these systems at room temperature, hydroxyapatite appeared to enhance the transformation rate of adenosine at around 140°C.

All these thermodynamic and kinetic treatments are used to evaluate quantitatively the energies and time scales needed for the chemical evolution toward the first life on early Earth.

Reference

Nakashima S. and Shota, D. (2001) In: "Geochemistry and the Origin of Life" (eds. Nakashima, S., Maruyama, S., Brack, A. and Windley, B.F.), Universal Academy Press, Tokyo, 135-178.