Development of CO2 fluid-water two-phase system: analysis of organic molecules in non-aqueous environment near hydrothermal system

*Kaito Seo[1,2], Kousuke Fujishima[3], Wataru Takahagi[1,4], Yoshinori Takano[4], Shigeru Shimamura[4], Masaru Tomita[1,2], Takazo Shibuya[4], Ken Takai[4]

1. Inst. Adv. Biosci., Keio Univ., 2. Environment & Info. Studies, Keio Univ., 3. Earth-Life Science Inst. Tokyo Inst. of Technology, 4. Japan Agency for Marine-Earth Science and Technology

Deep sea hydrothermal vent provides ideal condition for driving chemical evolution, with proton and thermal gradient, electrochemical disequilibrium, and mineral-catalyzed chemistry. However, biology relevant macromolecules such as proteins and nucleotide polymers are thermodynamically unstable in aqueous condition, and therefore dehydration condensation reaction at hydrothermal system was thought to be challenging. In the mid 2000’ s, lake of liquid CO2 was discovered under the seafloor sediments near hydrothermal vent at Yonaguni Knoll in the Okinawa Trough (Sakai, H., et al. 1990, Inagaki, F., et al. 2006). Geochemical modeling also suggests that Hadean ocean may have been rich with underwater CO2 lakes. The existence of non-aqueous and strongly hydrophobic fluid(water solubility < 1%) near hydrothermal system provides unique environment allowing different organic chemistry to take place, including the condensation reaction. Accordingly we developed a high-pressure reactor cell to contain both water and CO2 fluid (liquid or supercritical) to provide two-phase environment. We designed the reactor and three sampling ports to collect fluid samples from water, liquid CO2, and interface. This allows us to monitor the solubility, partitioning and reactivity of biology relevant simple organic molecules in the given environment. Current development and initial testing of the two-phase system will be discussed.

Keywords: origin of life, liquid CO2, hydrothermal vent, chemical evolution, two-phase system

