Oligopeptide formation of alanine under high pressure at 25 °C

C. FUJIMOTO[1*], A. SHINOZAKI[2], K. MIMURA[2], T. NISHIDA[2], H. GOTOU[3], K. KOMATSU[1] AND H. KAGI[1]

[1]Geochemical Research Center, University of Tokyo, Tokyo 113-0033, Japan (*correspondence: fujimoto@eqchem.s.u-tokyo.ac.jp)

[2]Graduate School of Environmental Studies, Nagoya University, Nagoya 464-8601, Japan

[3]ISSP, University of Tokyo, Tokyo 113-0033, Japan

Oligomerization of amino acids in prebiotic environments is an important step to the emergence of life. Oligomerization of amino acids was reported from experiments under high pressure and high temperature conditions simulating impact of comets, hydrothermal vents and diagenesis in sub-seafloor sedimentary environments [1-3]. However, it is unclear which factor (pressure or temperature) is dominant to oligomerization. In this study, we focus on exclusive effect of high pressure on oligomerization. We tested oligomerization of L-alanine under high-pressure at 25 °C.

Experiments were performed under 5–23 GPa at 25 °C using opposed-anvil apparatus and multi-anvil apparatus. A starting material was loaded in a high-pressure cell with three different conditions: wet, dry and solution (wet: L-alanine powder with its saturated aqueous solution, dry: L-alanine powder, solution: saturated L-alanine aqueous solution.). After decompression to ambient pressure, recovered samples were dissolved in pure water and analyzed using LC-MSMS.

Alanine dimer was detected from all the recovered samples and alanine trimer was detected from those recovered from pressures higher than 9 GPa. With increasing pressure, the yields of alanine dimer and trimer increased for each experimental condition (wet, dry, and solution). These results are consistent with the results of Fujimoto *et al.* [4]. The largest oligomer detected was 8-mer under the wet condition and the formed oligomers from dimer to 8-mer decreased with increasing the oligomer size. Water in the samples existed as ice VII under these experimental conditions and the oligomerization observed here was a solid-phase reaction.

This study revealed that oligomerization of amino acids occurs under high pressure at 25 °C with existence of ice VII which is known to exist in the interiors of icy planets. The interior of icy planets could be recognized as new site for abiotic oligomerization of amino acids.

[1] Sugahara & Mimura (2015) *Icarus* **257**, 103-112. [2] Imai & Honda (2010) *Viva Origino* **38**, 35-39. [3] Otake *et al.* (2011) *Astrobiology* **11**, 799-813. [4] Fujimoto *et al.* (2015) *ChemComm* **51**, 13358-13361.