Role of minerals for the oligomerization of amino acids under the primitive hydrothermal earth environments

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Introduction

Submarine hydrothermal vent systems are considered as plausible environments for the polymerization of biomonomers on the primitive earth [1]. However, the yield of condensation of amino acids is not so high. We showed the efficient elongation of oligoalanine peptide $(Ala)_4$ to $(Ala)_5$ and higher oligopeptides at 275 ºC by using our hydrothermal flow reactor [2]. In addition, we showed that the mineral-mediated hydrothermal flow reactor system (MMHF) is efficient to monitor hydrothermal reaction system containing minerals [3]. By using MMHF, we demonstrated that carbonate minerals enhance the elongation of oligoalanine peptides $(Ala)_4$ to $(Ala)_5$ under hydrothermal conditions.

Results and Discussion

However, it was not possible to monitor the influence of some minerals, such as clay minerals, at 275 ºC by using MMHF because these materials block the flow in MMHF. We attempted to use a batch reactor instead of MMGF to prevent. The elongation of $(Ala)_4$ proceeds within 60 s at 275 ºC so the elongation cannot be followed by the batch method unless the reaction temperature is adjusted at below 175 ºC. After the very long exposure at high temperatures, alanine peptides are finally degraded to diketopiperazine and alanine monomer.

It was surprising that the elongation reaction proceeded at much lower temperature below 275 ºC. The minerals showed basically the same influence to the elongation of $(Ala)_4$ shown at 275 ºC. This fact seems to be inconsistent with an argument that the oligomerization occurs as a non-equilibrium process under the hydrothermal condition [1]. Although the enhancement by carbonate minerals was observed, clay minerals did not show notable influence to the elongation reaction. We will demonstrate and summarize these influences for the elongation reaction.

[1] Imai et al. (1999) *Science* **283**, 831-833. [2] Kawamura et al. (2005) *J Am Chem Soc* **127**, 522-523. [3] Kawamura et al. (2011) *Astrobiology* **11**, 461-469.