Effects of pressure, temperature, reaction time and clay mineral on the polymerization of glycine-methionine mixture system

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Prebiotic polymerization of amino acid is the most essential process to promote the chemical evolution for origin of life. Several experiments to polymerize amino acids have been attempted by previous investigators, but most of previous study was only performed using single amino acid, such as alanine and glycine. It is still uncertain if peptide can be formed from the mixture of methionine and glycine system at high pressure-temperature and non-aqueous conditions. Therefore, anhydrous high P and T experiments were performed under various pressures of 0.5-150 MPa at 100-200^{o}C for 1-8 days. Such conditions may simulate the upper oceanic crustal environment of the primitive Earth. In addition to the methionine and methionine-glycine mixture system, the influences of Na-montmorillonite on peptide formation were also examined. Total of 15 experiments were performed during the course of this thesis study. The products were carefully analyzed using HPLC.

(1) The products show various colors ranging from white to dark brown, depending on reaction time, pressure and temperature. (2) Dimmer of glycine (Gly-Gly), dimmer of methionine (Met-Met), peptide of glycine and methionine (Gly-Met), and those diketopiperazines (DKP) were certainly formed under high temperature and pressure conditions. (3) Gly-DKP is the most abundant products to be polymerized in the series of experiments. (4) In the methionine-glycine system, the highest yield was achieved at 90 MPa. (5) Na-montmorillonite behaved as a catalyst to polymerize Gly-DKP and Met-DKP, but did not contribute to form any peptides including Met-Gly peptide. It is noteworthy that formation of by-products, such as melanoidines, is controlled mainly by pressure, increasing the effectiveness of polymerization of amino acids.

The above results suggest that amino acid polymerization in mixed system is more complicated than the single amino acid system. But peptides can be formed even in the complex system suggesting that chemical evolution could have happened in the primitive Earth oceanic crust.