Dehydration experiment of alanine under high pressure assuming chemical evolution probable in the upper crust.

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1. Introduction

Almost all previous studies of the origin of life were assuming that the chemical evolution was taking place in the oceanic environment and the first life appeared in the ocean. In the oceanic environments, it is questionable if dehydration polymerization of organic matter would proceed, because of the excess amounts of water. The water-poor condition is more place to proceed dehydration polymerization reaction. The inside of crusts may be the suitable place for this reaction rather than within oceans. Based on this point, Nakazawa et al. (1993) proposed the hypothesis: Chemical evolution in the upper crust. The critical point of this hypothesis is if dehydration polymerization of simple organic matter can proceed under crustal conditions. The suitable experimental method for the dehydration polymerization, however, dose not exist. Therefore, establishment of the experimental method is set as the primary purpose for this study. Some experiments are also performed in order to examine if the new experimental method can reproduce the chemical reaction within the upper crust and to examine behavior of amino acids in the upper crustal condition, in particular sediment-subduction system.

2. Experiments

L-alanine adsorbed on and intercalated in montmorillonite was prepared as a model of sea sediment as the starting material. The samples were sealed in gold capsules together with CaO and both were separated by gold plate with some pin holes. CaO is the adsorbant of water produced by the dehydration reactions. The capsules were placed in a belt type high pressure appparatus and applied the pressure of 2.5GPa and temperature of 250 to 450 degrees centigrade for 6 hours. The conditions correspond to those of 100km depth of the Earth's surface. The samples recovered were analyzed by using X-ray diffractometer (XRD) and Fourier transform infrared spectroscopy (FT-IR) for solid products and high speed liquid chromatography (HPLC) and laser Raman spectroscopy (LRS) for the samples prepared by water dispersion and centrifugal separation of the run product.

3. Results

(1) XRD analyses of the run products indicate that montmorillonine and quartz are still present at 2.5GPa, 250 degree centigrade, but changed to tobelite (ammonium mica), jadeite and quartz at 350 and 450 degree centigrade. A part of CaO has been changed to Ca(OH)2 for all experimental runs indicating the appearance of water as dehydration products.

(2) Peaks of O-H, C-H and C=C stretching vibrations are shown in the FT-IR spectra of run products at 250 and 350 degree centigrade, similar to those of kerogen. Peak of C=C stretching vibration indicating the presence of graphite are shown in that of the run product at 450 degree centigrade.

(3) Any polymer of alanine has not been detected by HPLC analysis for the water-extracted samples of all run products.

(4) Peaks of C-H stretching vibrations are identified in the LRS spectra of the supernatant of the water dispersed and centrifuged samples of the run product at 250 degree centigrade. Those agree well with the spectrum of polyopropylene.

4. Discussion

The present results reveal that L-alanine has been dehydrated and successively changed to polypropylene, kerogen and graphite depending on the temperatures from 250 to 450 degree centigrade under 2.5GPa. This is the monotonous process of carbon polymerization. Under lower pressures and at lower temperatures, polyamid and peptide formation is highly probable as in-between of alanine and polypropylene. The present result seems to support the hypothesis: Chemical evolution in the upper crust. The new finding that tobelite (NH4-mica) is formed from the model material of sea sediment under the condition of 100km depth of the Earth's surface suggests a probable source of nitrogen in the deep Earth.