

Analysis of Prebiotic organic compounds in High-Temperature and High-Pressure Environments

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It was hypothesized that the terrestrial life was generated in the course of chemical evolution by using organic compounds generated in extraterrestrial environments and/or in primitive. Those organic compounds would have been thermally transformed in the submarine hydrothermal systems (SHSs). A wide variety of organic compounds were found in meteorites. Recently organic globules were found in Tagish Lake meteorite, which suggest that proto-cellular structure may have been formed either in parent bodies of meteorites (PDM) or SHSs. In both environments, organic compounds were exposed to high-temperature and high-pressure environments. Organic globules may have been formed in such environments.

In the present study, the organic compounds were made from simulated primitive earth atmosphere (or interstellar media) by the action of proton irradiation, and they were heated under high-temperature, high-pressure condition by using a flow reactor (FR). Organic compounds before and after heat -treatment was monitored by microscopic method and amino acid analysis.

The carbon monoxide, nitrogen and water were enclosed in the Pyrex container. The mixture was irradiated with proton beams from a van de Graaff accelerator (TIT), which was simulation of the action of cosmic rays. Hereafter the product was referred as CNW. CNW was heated at 200, 300, 400 degrees-C for 2 min in FR. This processing simulated the thermal alteration processes of CNW in either SHSs or PDM. The structural changes before and after the thermal processing were observed by TEM. Molecular weight was estimated by gel filtration chromatography (GFC). The stability of the compounds were evaluated by amino acid analysis after acid hydrolysis: Amino acids generated after acid hydrolysis was determined by cation-exchange HPLC (Shimadzu LC-10A).

TEM images before heating showed that CNW had grainy structures. After thermal processing, fiber-like structures were appeared. These globules were smaller than those found in Tagish Lake meteorite. It was confirmed that this structure changed into a fiber structure by heating it. The molecular weight of CNW before heating was estimated as several thousands by GFC. Molecular weight has gradually became small by raising the temperature. A number of amino acids have been generated from CNW after hydrolysis, where glycine and alanine were major. These amino acids has decreased by raising the temperature. But the stability was much higher than the amino acids monomer.

Organic globules observed in Tagish Lake meteorite suggest that proto-cellular structure have been delivered by meteorites. The present study suggests that such organic globules could be formed in thermal processes. Further study is now planned by using an autoclave for the thermal alteration of simulated extraterrestrial organic compounds.