

Organic molecules synthesis by impact reactions among meteoritic minerals, water, and nitrogen

Yoshihiro Furukawa[1]; Toshimori Sekine[2]; Masahiro Oba[3]; Takeshi Kakegawa[4]; Hiromoto Nakazawa[5]

[1] Graduate School of Science, Tohoku Univ.; [2] AML/NIMS; [3] Tohoku University; [4] IMPE., Tohoku Univ.; [5] NIMS

1. Introduction

Atmosphere of the early Earth is thought to be mainly composed of CO₂ and N₂. How and when abundant organic molecules appeared in such an inorganic world are fundamental inquiries into the origin of life. Lunar samples and lunar crater records suggest that impacts of meteorites were frequent on the Hadean Earth. Geological evidences suggest that ocean had already formed to this time. Meteoritic materials indicate that ordinary chondrite, the most abundant meteorite, contains a substantial amount of iron-nickel and small quantities of solid carbon. Here we report an impact synthesis of some biomolecules and their precursors from meteoritic minerals, water, and nitrogen all of which would have been available during impact events on Earth's early oceans.

2. Experimental

We demonstrated shock-recovery experiments to simulate ocean impacts. Samples are powder mixtures composed of iron, nickel, solid carbon (¹³C), water, and nitrogen. The mixtures are enclosed in stainless-steel container and sealed. The container is impacted by a flyer made of stainless-steel with a single-stage propellant gun. After the experiments, organic compounds are carefully extracted from the container and analyzed with LC/MS and GC/MS after suitable treatment.

3. Results and Discussion

Detection of ¹³C-composed organic molecules proved those syntheses in this experiment. Biomolecules and their precursors identified in the present shock recovery experiments are carboxylic acids, and amines. In addition to these organic molecules, glycine was also identified in a sample contains ammonia in starting material. Natural impacts of meteorite might create more various and abundant organic molecules because natural impacts necessarily have greater duration and pressure than those of the present experiments and there might be additional, as yet undetermined, products in present study. These results suggest that impacts of extraterrestrial objects on Hadean oceans produced various and abundant bio-organic molecules.