Stability and dissolution characteristics of amino acids in ocean bottom sediment under hydrothermal conditions

MIHO ITO[1], LALLAN PRASAD GUPTA[2], HARUE MASUDA[1], HODAKA KAWAHATA[2]

[1]Department of Geosciences, Osaka City University, Japan Email: mihoi@sci.osaka-cu.ac.jp
[2]Geological survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST), Japan

In order to understand subseafloor biosphere in the hydrothermal system, it is important to know about stability of amino acid compounds because they are major constituents of organisms. Carbonaceous sediments collected from the west of Hawaii (20°N, 175°56'E) were reacted with artificial seawater (3% NaCl solution) in an air-tight vessel at elevated temperatures in our laboratory.

The total hydrolysable amino acid (THAA) concentration in the starting sediment was 3129 pmol/mg. After 240 hours of treatment at 100 ^{O}C, the THAA concentration in sediment decreased and only two thirds of the starting amount remained. At 200 ^{O}C and after the same period of treatment, the THAA concentration decreased to 125 pmol/mg. The THAA in the reacted solution increased to 36.5 nmol/ml at 100 ^{O}C after 240 hours of treatment, while it decreased to 18.6 nmol/ml at 200 ^{O}C after the same interval.

THAA in the sediment after the hydrothermal experiments decreased due to dissolution and/or decomposition. The rates of dissolution and decomposition of the amino acids increased with time and temperature. At 200 ^{O}C, the dissolution rate was higher than the decomposition rate during the early stage of the experiment, while the decomposition rate became higher than the dissolution rate in the later stage. Consequently, the THAA concentration decreased in the reacted sediment.

After analysing changes in individual amino acids, we found that glutamic acid and gamma-amino butyric acid followed by glycine were rather tolerant of high temperatures, while serine and aspartic acid became more unstable at relatively higher temperatures. Our results demonstrate that labile organic matter like amino acid_compounds hardly survive in the ocean bottom sediment at temperatures higher than 200 ^{O}C.

Chondrule-bearing CAI from Y81020 CO3.0 chondrite

S. ITOH AND H. YURIMOTO

Department of Earth and Planetary Sciences, Ookayama, Meguro, Tokyo, JAPAN (sitoh@geo.titech.ac.jp)

Introduction: Ca-Al-rich inclusions (CAIs) are the oldest materials left over from the formation of the solar system [1]. Chondrules were also formed in the early solar system, but it is believed that they are ~2 Ma younger than the CAIs [2-4].

Although these dating constrain time scales of evolution of the early solar system, the forming region is unresolved. Because of the time gap and differences of chemical and isotopic compositions, it is believed that chondrule-forming event is independent of CAI-forming event [5].

Results: Here, we report the first observation of a ^{16}O-poor chondrule fragment embedded in a ^{16}O-rich CAI mesostasis, regarded as the chondrule-bearing CAI (named as A5) from Y-81020 CO3.0 chondrite. The chondrule-bearing A5 CAI is about 100 μm across and it consists of a ^{16}O-poor large central polycrystalline melilite ($Åk_{10-13}$) clast with small O isotopic zoning and ^{16}O-poor three-pyroxene assemblage included troilite and metal, as well as enstatite, augite and pigeonite, enclosed by a ^{16}O-rich porous glassy mesostasis. These mesostasis consists of Al-rich clinopyroxene filaments embedded in Al-rich glass. The chemical composition of mesostasis affected the nearby phases of melilite and pyroxene. On the basis of these petrologic and isotopic results, we conclude that the A5 CAI contains a fragment of a chondrule.

Discussion: We propose the model for indicating that CAI-forming and chondrule-forming events are not independent but overlapped during early solar system evolution[6]. Both ^{16}O-poor melilite with small O isotopic zoning and ^{16}O-rich glassy mesostasis are present in the CAI whereas the chondrule fragment is ^{16}O-poor, suggesting that CAIs and chondrules formed during oscillation in O isotopic composition in the solar nebula. These results can be explained by dynamic material mixing in the solar nebula around violent proto-sun. This model is consistent with fluctuating X-wind model that chondrules and CAIs were possibly formed by X-ray flare heating arisen as a result of the time-dependent interaction of a protoplanetary disk with the magnetosphere of the proto-sun [7].

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