Search for Amino Acid Precursors in Carbonaceous Chondrites and Cosmic Dusts. K. Kobayashi[1,2], H. Mita[3], Y. Kebukawa[1], Y. Ishikawa[1], T. Kaneko[1], A. Yamagishi[2,4,5], and Tanpopo WG[5], [1]Yokohama National University, [2]National Institutes of Natural Sciences, [3]Fukuoka Institute of Technology, [4]Tokyo University of Pharmacy and Life Science, [5]Japan Aerospace Exploration Agency

Introduction:

Wide variety of amino acids has been identified in water extracts from carbonaceous chondrites. It seems that organic compounds in carbonaceous chondrites including amino acids were promising sources for the first terrestrial life. Amino acids in carbonaceous chondrites have been determined after hot water extraction and acid hydrolysis. Hydrolyzed fractions gave more amino acids than nonhydrolyzed fractions, which shows that a part of amino acids in meteorites exist in bounded form or as precursors. It is controversial, however, that major part of amino acids found in carbonaceous chondrites are free or bounded. Some scientists think that amino acids are formed by the Strecker synthesis in parent bodies of meteorites, and most of them are in free forms. Another possible scenario of origins of meteoritic amino acids is they were originally formed in ice mantles of interstellar dust particles. When we irradiated a mixture of major molecules found in the ice mantles (H2O, NH3, CO and/or CH3OH) with high-energy particles, complex amino acid precursors with high molecular weights were formed [1].

Another important carriers of extraterrestrial organic compounds are cosmic dusts, since it was estimated that more organic carbons were delivered by cosmic dusts than by meteorites [2]. It is not clear, however, that cosmic dusts could carry amino acids since cosmic dusts have been collected in terrestrial biosphere where contamination of amino acids are inevitable.

We are now planning a new space experiment named TANPOPO by utilizing the International Space Station (ISS) [3]. Aerogel (ultralow-density silica gel) will be exposed to space on the Exposed Facility of Japanese Experimental Module (Kibo) of ISS for years to collect cosmic dusts. Amino acids in cosmic dusts will be analyzed after returning the aerogel to the Earth. Since cosmic dusts are so tiny, we should apply a new protocol of amino acid analysis for extreme-low level of amino acids.

Here we will present the present situation of the development of amino acid precursors in geo- and cosmological samples.

Samples:

In order to develop a technique to low-level amino acids in geological samples, we used soils sampled in Atacama Desert, Chile. Atacama Desert is ultra-arid environments, and sometimes regarded as Mars analogue.

Targeted carbonaceous chondrites are Antarctic meteorites (A-881458, Y-793321, Y-980051, Y-982086).

Experimental:

Amino acids in soil samples were extracted with the following two techniques: (1) Hot water extraction and (2) digestion with 5 M HF – 0.1 M HCl. Both extracts were hydrolyzed with 6 M HCl at 110°C for 24 h. Amino acids were determined by HPLC. Blank run was performed by using sea sand after heated at 500°C.

Results and Discussion:

HF digestion of the soil sample gave much more amino acids than hot water extraction. Thus sole hot water extraction would be not adequate for analysis of cosmic dusts or carbonaceous chondrites with low concentration of amino acids. HF digestion gave, however, higher blank amino acids than hot water extraction. We are now constructing a new protocol of amino acid analysis with sequential extraction / digestion techniques, and will show it in the symposium.

Nonhydrolyzed fractions will be also analyzed to determine possible amino acid precursors such as hydantoins.

The analytical procedures applied to the Antarctic meteorites will also be applied to the returned samples by the Tanpopo Mission. The Tanpopo Mission is now scheduled to start in 2015, and aerogels will be returned to the Earth after 1-3 year's exposure to the low Earth orbit. Thus the first cosmic dust samples captured in aerogel will be obtained after 2016. Aerogel aliquot with tracks and end particles will be cut, be digested with HF-HCl, and be hydrolyzed. Amino acid enantiomers in the hydrolysates will be determined by micro two-dimensional HPLC system developed by Hamase et al. [4].

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