Exposure experiments of organic compounds on the JEM, ISS, in the TANPOPO mission.

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Introduction: The Tanpopo mission is a Japanese astrobiological experiment which will be conducted on the Japanese Experiment Module (JEM) of the International Space Station (ISS). The Tanpopo mission consists of six subthemes: 1) capture of microbes in space, 2) exposure of microbes in space, 3) exposure of organic compounds in space, 4) capture of organic compounds in micrometeoroids in space, 5) evaluation of ultra low-density aerogel developed for the Tanpopo mission, and 6) capture of space debris at the ISS orbit (approximately 400 km altitude).

Here, we overview the exposure experiment of organic compound in space environment (Subtheme 3). Since many kinds of organic compounds, especially, amino acids which are ones of most important organic compounds in living organisms, are found from extraterrestrial materials, extraterrestrial and outer-solar environments are thought as the place for the prebiotic organic compound synthesis. Then, it is proposed that the first organisms on the earth was born from the prebiotic organic compounds delivered from extraterrestrail environments into the early earth on meteorites, micrometeorites and/or comets. In order to discuss the possibility of this hypothesis, alteration of prebiotic compounds in space environments should be clear. Therefore, we will expose some prebiotic organic compounds on the exposure facility at ISS-JEM.

Exposure sample: Glycine, isovaline, hydantoin, ethylmethylhydantoin and complex organics (CAW) are chosen for the exposure. Glycine is the most primitive and common amino acid detected from meteorites and isovaline is a relatively abundant non-protein amino acid whose chirality in meteorites were non-racemic. Since free amino acids were rare in meteorites, amino acids detected from meteorites were existed as their precursors. There are two plausible amino acids precursors; low molecular weight precursors and high molecular weight ones. Hydantoin and ethylmethylhydantoin are ones of plausible low molecular weight precursors for glycine and isovaline, respectively. CAW which is a simulated material of interstellar medium prepared by proton radiation into mixture of CO, NH_3 and H_2O is a high molecular weight precursors for amino acids, and is a complex organics that means a dificult to identified its chemical structure.

Simulation experiments: In the space environments, uv-light and cosmic rays (heavy ions and γ-ray) will cause the alteration of organic compounds. Therefore, simulation experiments were studied using Xe-excimer lamp (uv 172 nm), synchrotron radiation at NewSUBARU BL06 (uv > 130 nm), ^{60}Co γ-ray radiation (Ouantum Beam, JAEA) and carbon ion beam (290MeV, NIRS). γ-Ray and heavy ion beam irradiation with dose of ISS environment for one year induced little decomposition of organic compounds. However, uv irradiation was critical for organic compounds. Although almost all glycine and isovaline would be decomposed, approximately 29 % and 72% of hydantoin and ehtylmethyl hydantoin, respectively, would remain after one year uv irradiation at ISS environment. Furthermore, 36% of CAW would remain after one year uv irradiation at the environment. In those experiments, free amino acids would be difficult sto survive in space environments, and amino acids precursors were more stable than free amino acids. Therefore, extraterrestrial amino acids precursors would be effective source for origins of life on the earth.

Experimental design: In order to demonstrate above conclusions on the ISS-JEM, five compounds will put into the holes on the small aluminum plates. The plates covered with MgF or quartz windows will expose into space at ISS orbit for one to three years.

Peptide formation in space environment: In addition, Nakagawa and his colleagues were found that dialanine was formed from alanine films by uv-irradiation. Then, we will demonstrate a peptide synthesis with uv-irradiation in the space environment. This experiments will show the possibility of peptide formation in space.