宇宙科学シンポジウム@JAXA/ISAS
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惑星間塵中有機物の生命起源との関連を探る：宇宙実験「たんぽぽ」の準備状況

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Abstract

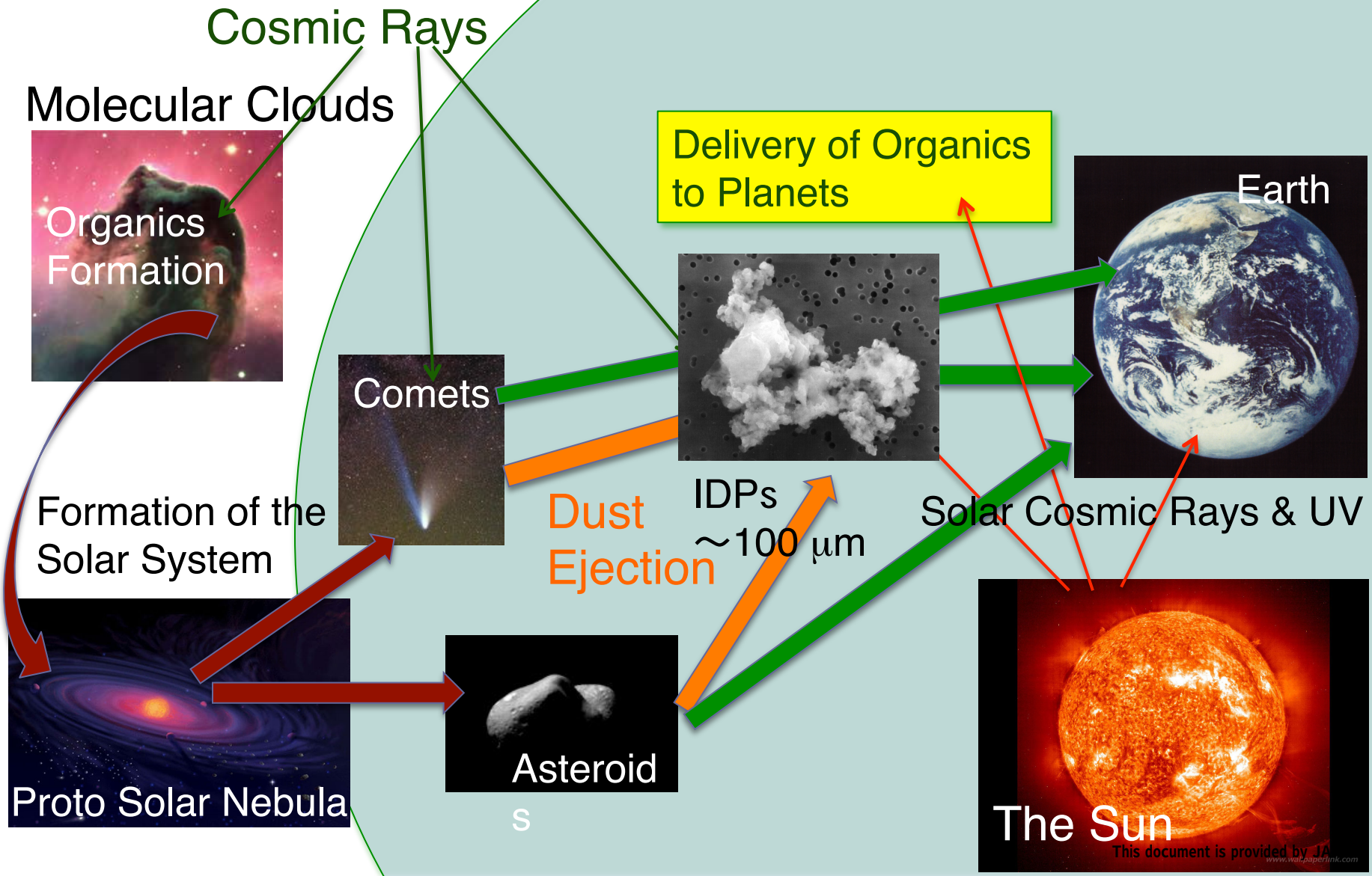
A wide variety of organic compounds have been detected in extraterrestrial bodies, and their relevance to the origins of life is widely discussed. It was suggested that major carriers of extraterrestrial organic materials were interplanetary dust particles (IDPs). Since most IDPs have been collected in terrestrrial environments, presence of amino acids of extraterrestrial origin has not been confirmed. Stability of organic compounds in IDPs in space was not studied yet.

We are planning a novel astrobiology mission named *Tanpopo* by utilizing the Exposed Facility of Japan Experimental Module (JEM/EF) of the International Space Station (ISS) (Yamagishi et al., 2009). Two types of experiments will be done in the Tanpopo Mission: Capture experiments and exposure experiments. In the capture experiment, we are going to use extra-low density aerogel, since both cosmic dusts and ISS are moving at 8 km s^{-1} or over. We have developed novel aerogel whose density is 0.01 g cm^{-3}.

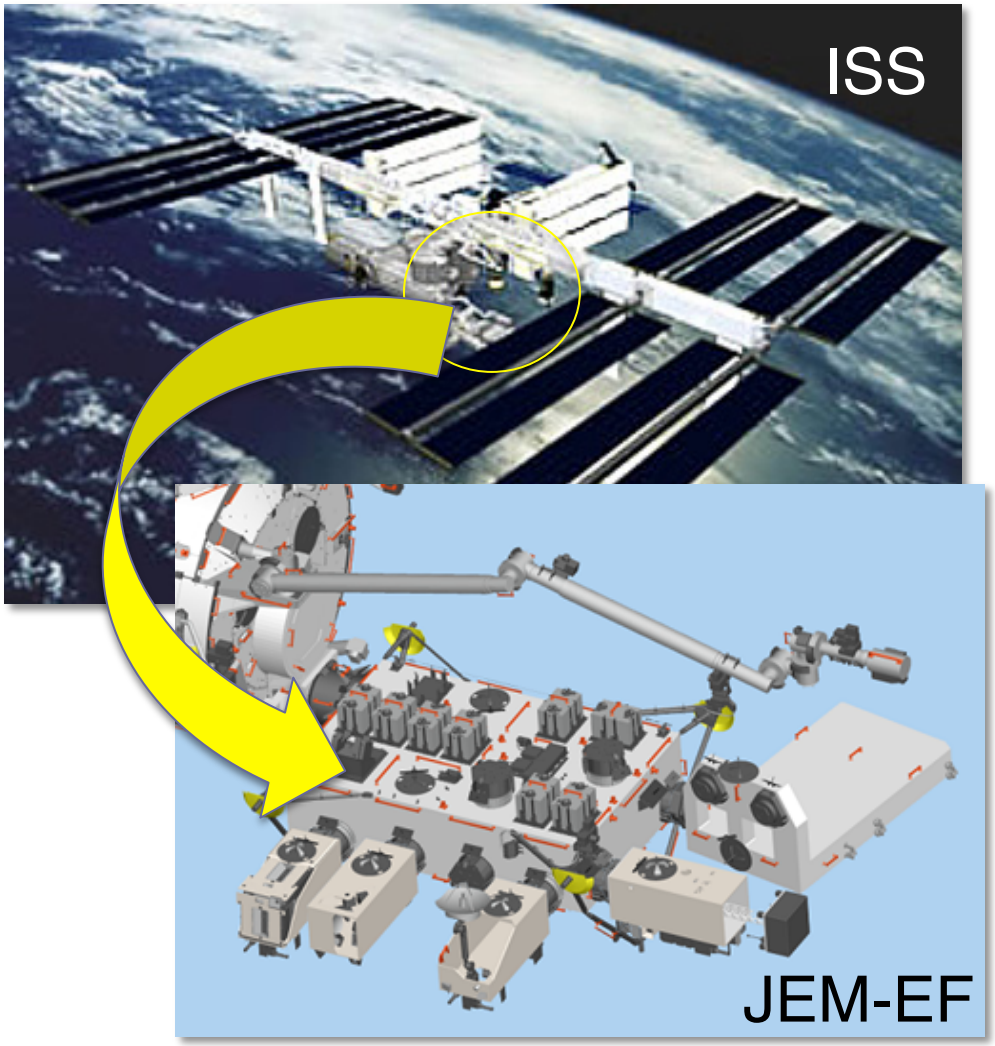
For the exposure experiment, we chose amino acids (glycine and isovaline) and their precursors to compare their stability and reactions in space.

The Tanpopo Mission has been accepted as a JAXA mission, which is now scheduled to start in 2015. Samples will be retrieved 1-3 years after launch.

A Scenario of Formation, Alteration and Delivery of Organic Compounds in Space

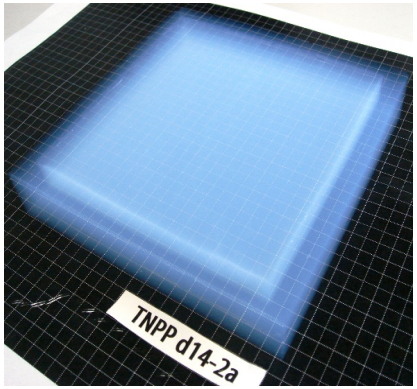


The Tanpopo Mission on the Exposed Facility (EF) of JEM (*Kibo*), ISS



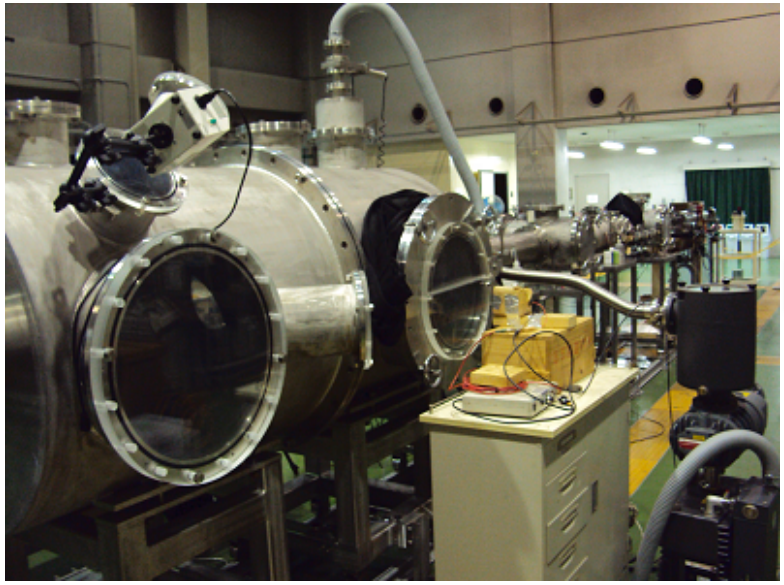
Objectives:

- Microbe capture
- Microbe exposure
- Analysis of organics in cosmic dusts
- Organics exposure
- Development of new aerogel
- Monitoring of space debris



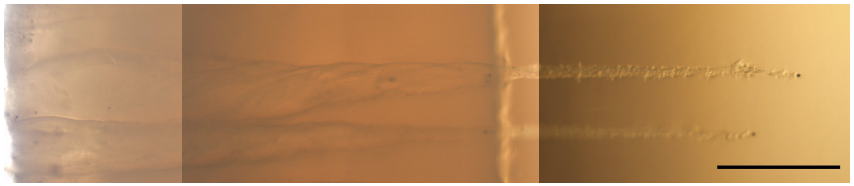
Ultra low-density (0.01 g cm^{-3}) Aerogel is used to collect cosmic dusts and terrestrial microorganisms

Capture of Space Dusts in Space: Ground Simulation with a 2-Stage Light Gas Gun

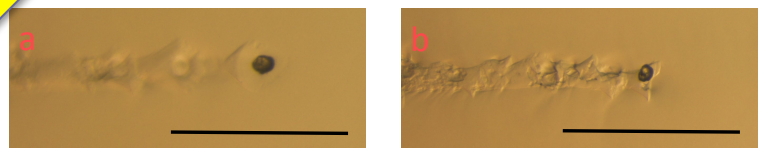


Simulation with a Two-stage light gas gun (ISAS)

Tracks and Terminal Particles
after 2-Stage Light Gas Gun Experiments



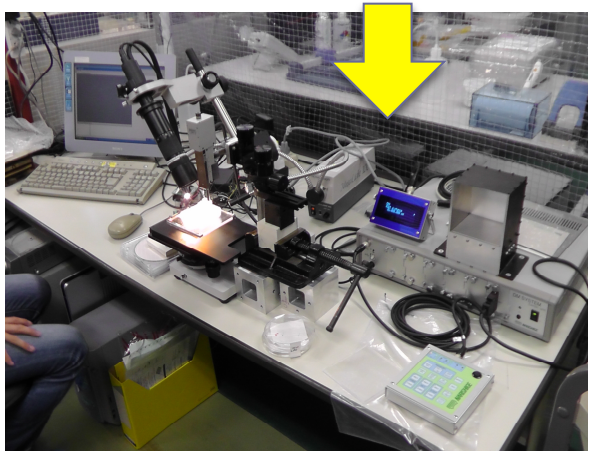
Tracks: Bar = 2 mm

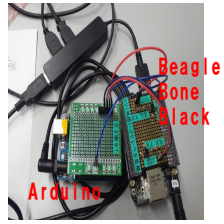


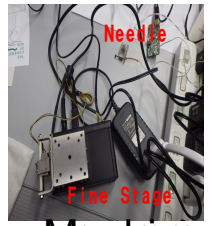
Terminal Particles: Bar = 0.5 mm

Kawaguchi *et al*. *Orig*. *Life Evol*. *Biosph*., **44**, 43–60 (2014)

- ✓ Amino acid analysis (2D-HPLC etc.)
- ✓ Characterization of complex organics (SXEM-XANES etc.)



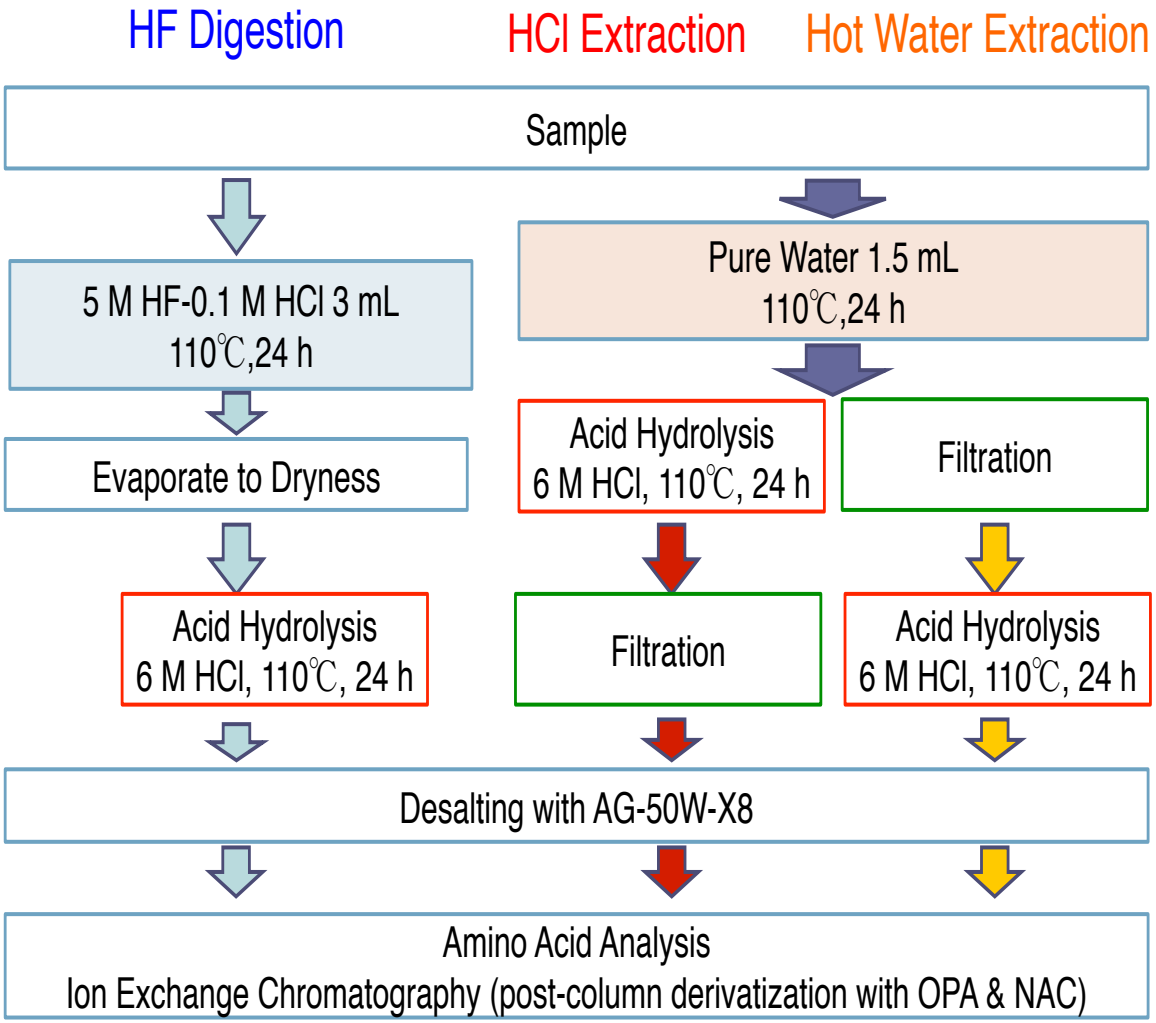


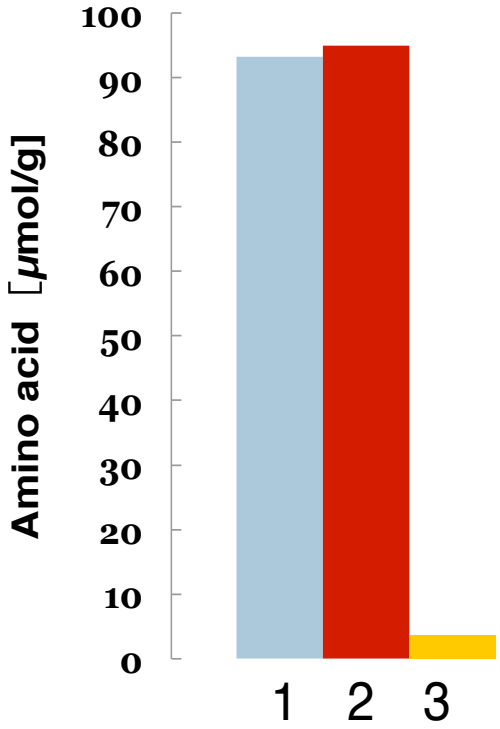


Prototype of TanpopoKeystone Machine

This document is provided by JAXA.

Extraction of Amino Acids from Captured Cosmic Dusts



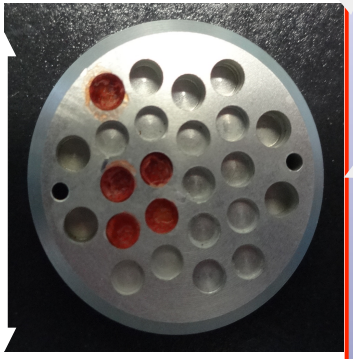


Yield of amino acids by:

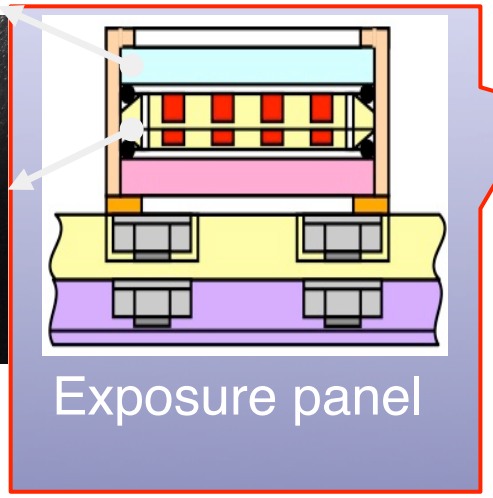
1. HF digestion
2. HCl extraction
3. Hot water extraction

(Sample: YNU campus soil)

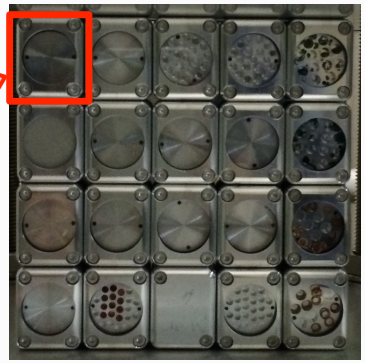
Exposure of Organic Compounds



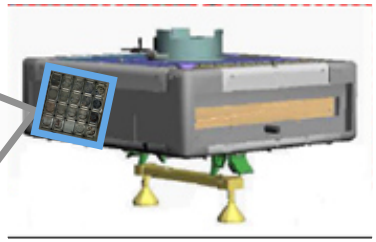
Aluminum plate



Exposure panel



Exposure panel

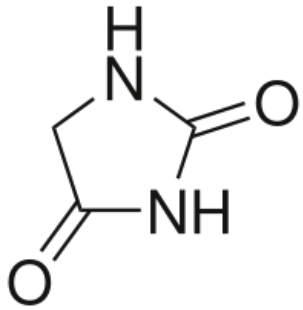


Ex HAM

Windows: (MgF_2 or quartz glass)

Samples: Amino acids and their precursors

- Glycine
- Hydantoin (A precursor of glycine)
- Isovaline (α-methyl non-protein amino acid)
- 5-Ethyl-5-methyl hydantoin (A precursor of Isovaline)
- "CAW" (Complex amino acid precursors produced by proton irradiation of a mixture of CO, NH_3 and H_2O)



Hydantoin

Estimated Recoveries After 1 Year Exposure at ISS

	UV	γ-Ray	Heavy ion	Temperature	Total
Glycine	2×10^{-3}	100	100	100	2×10^{-3}
Isovaline	3×10^{-3}	>99	100	100	3×10^{-3}
Hydantoin	29	100	100	100	29
Ethylmethylhydantoin	72	>99	100	100	72
Complex organics (CAW)	36	100	100	100	36

✓Cosmic rays will not affect for alteration of amino acids their precursors.
✓UV is the largest effective energy source for alteration of amino acids their precursors.

Ultraviolet light: Xe-excimer lamp (172 nm) & New SUBARU BL-6 (> 130 nm)
γ-rays: ^{60}Co source at JAEA Takasaki; 200 kGy (> 1000 yr)
Heavy ion: Carbon ion (290 MeV) at HIMAC (NIRS); 16 kGy (ca. 160 yr)
Temperature: Max. 80°C

K. Kobayashi et al., *Trans. Jpn. Soc. Aeronaut. Space Sci.*, **12**, No. ists29 (2014).