Exposure of amino acids and their precursors to space in the TANPOPO mission: The first Japanese astrobiology experiments in low earth orbit

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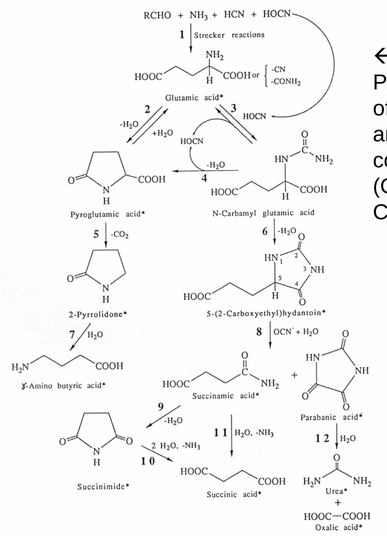
Introduction — Alteration of organic compounds in space environment

Since a diverse suite of amino acids is found in carbonaceous chondrites, exogenous delivery of organic matter could have played an important role for the prebiotic chemical evolution on the early Earth. The interplanetary dust particles (IDPs) are considered to be the major carbon source (Chyba & Sagan 1992). However, the organic matter in IDPs is susceptible to the cosmic and solar radiation due to their small nature.

Amino Acids and Their Precursors

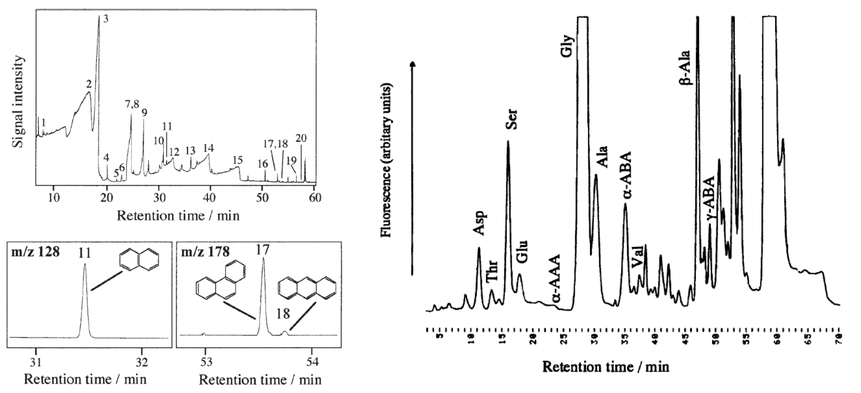
- **Amounts of free amino acids are minor components**
- **In the extraterrestrial samples, amino acids existe as their precursors**

1. low molecular weight organic compounds



← Plausible routes of amino acids and related compounds (Cooper & Cronin, 1995)

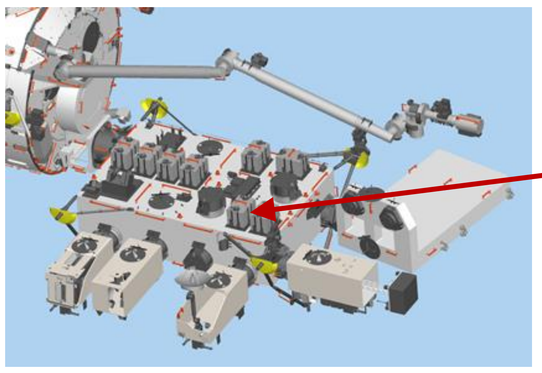
2. high molecular weight complex organic compounds



Pyrogram (left) and ion-exchange chromatogram (right) of high molecular weight complex organic compounds formed in the simulated interstellar gas mixtures (Takano et al. 2004 & Kobayashi et al. 2004)

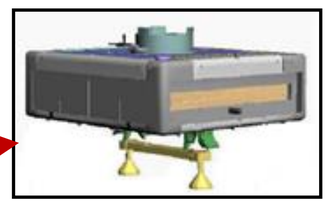
Exposure Experiments

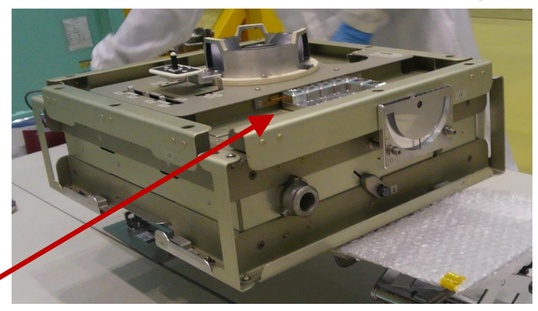
Exposure Facility at KIBO



ExHAM

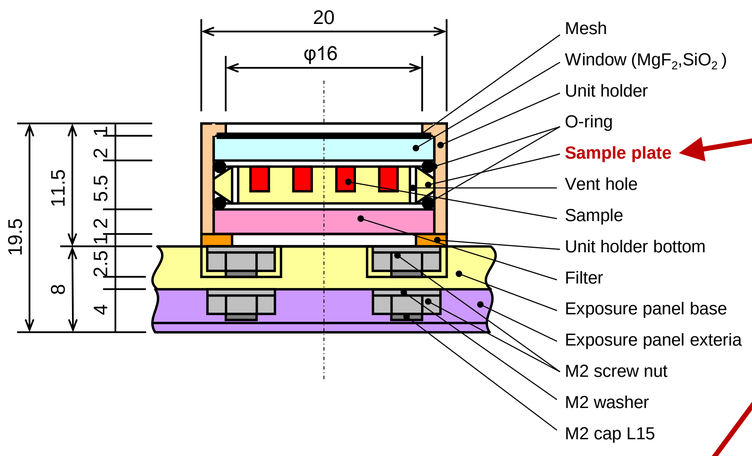
(Exposed Experiment Handrail Attachment Mechanism)



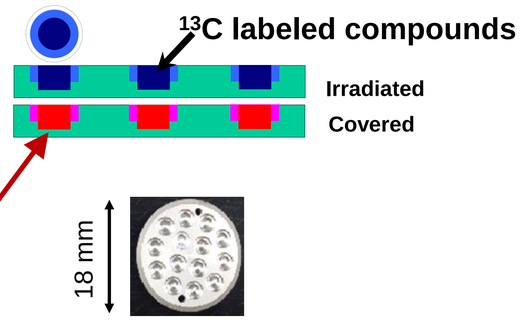


Exposure panel | **Thermometer panel** | **Reference panel**

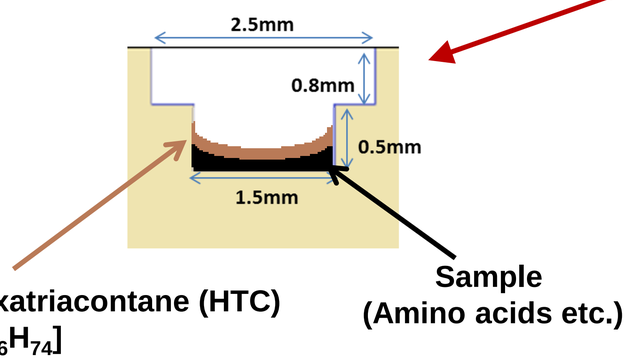
Exposure unit



Sample plates (Al)



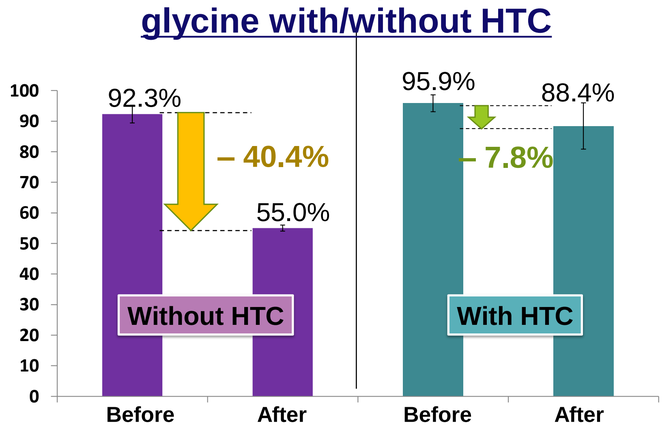
Sample pit



Hexatriacontane (HTC) [$C_{36}H_{74}$]

In order to prevent the sample lost during the experiments and transportations

UV irradiation experiments of glycine with/without HTC

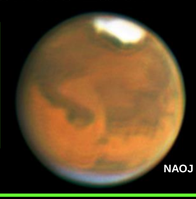


HTC prevents glycine decomposition by UV
→ We can calculate the UV-induced glycine decomposition rate by subtracting the protection effect of HTC

TANPOPO — Astrobiology experiments at ISS

Analysis of interplanetary migration of microbes, organic compounds concerning with origins of life on the Earth

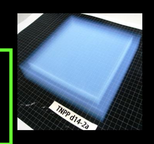
Panspermia: Possible migration of life through space.
1) Collection of microbe
2) Survival of microbes



This poster

Chemical evolution: Transfer to Earth from extraterrestrial region
3) Collection of organic compounds
4) Alteration of organic compounds

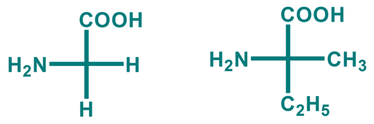
Application:
5) Development of new aerogel
6) Monitoring of space debris



Alteration of Organic Compounds in Space Environments

Target compounds for 1, 2 and 3 years of exposures

- **Free amino acids: glycine and isovaline**



- **Low MW amino acid precursors: hydantoin and 5-ethyl-5-methyl-hydantoin**

- **High MW complex organic compounds (CAW)**
  Complex amino acid precursors produced by proton irradiation to a mixture of **CO, NH_3 and H_2O**

Estimated Remains after One Year Exposure at ISS

Estimated remains (%) after 1 year exposure at ISS orbit

	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 and their precursors**
- **UV is the largest effective energy source to alteration of amino acids and their precursors**

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

The Mission Has Just Started!

[2015, JST]
April 15: The exposure panels were launched with SpaceX Dragon 6

April 17: Rendez-vous with ISS
May 15: The exposure panels were fixed with ExHAM and waiting for exposure
May 26: The exposure has started!!!

Stay tuned!