

土星衛星エンセラダスのプルーム物質の化学・生命探査：サンプルリターンとその場質量分析の重要性

A space exploration for Enceladus' plumes: importance of sample return and in-situ mass spectrometry

関根 康人^{1*}, 高野 淑識², 矢野 創³, 船瀬 龍⁴, 高井 研⁵, 石原盛男⁶, 渋谷 岳造⁵, 橋 省吾⁷, 倉本 圭⁸, 藪田 ひかる⁹, 木村 淳⁸, 古川 善博¹⁰

Yasuhito Sekine^{1*}, Yoshinori Takano², Hajime Yano³, Ryu Funase⁴, Ken Takai⁵, Morio Ishihara⁶, Takazo Shibuya⁵, Shogo Tachibana⁷, Kiyoshi Kuramoto⁸, Hikaru Yabuta⁹, Jun Kimura⁸, Yoshihiro Furukawa¹⁰

¹ 東京大学・新領域, ² 海洋研究開発機構 海洋・極限環境生物圏領域, ³ JAXA ISAS, ⁴ 東京大学・工, ⁵ 海洋研究開発機構 PEL, ⁶ 大阪大学・理, ⁷ 北海道大学・理, ⁸ 北海道大学・理, ⁹ 大阪大学・理, ¹⁰ 東北大学・理

¹Dept. Complexity Sci. & Engr., Univ. Tokyo, ²Inst. Biogeosciences, JASMTEC, ³ISAS, JAXA, ⁴Dept. Aeronautics & Astronautics, Univ. Tokyo, ⁵PEL, JAMSTEC, ⁶Dept. Physics, Osaka Univ., ⁷Dept. Natural History Sci., Hokkaido Univ., ⁸Dept. CosmoSci., Hokkaido Univ., ⁹Dept. Earth & Space Sci., Osaka Univ., ¹⁰Dept. Earth Sci., Tohoku Univ.

Here we propose a sample-return mission of water-rich plumes erupting from warm fractures near the south pole of Enceladus. During collection of plume samples, the spacecraft will conduct in-situ gas analyses with a high-resolution multi-turn time of flight mass spectrometer. The mass spectrometry would provide the abundances and isotopic compositions of major gas species included in the plumes. These observational data would allow us to discuss the temperature and isotopic heterogeneity of primordial volatiles in the Saturn-forming region of the protoplanetary disk, geochemical processes occurred in Enceladus' ocean, and possible metabolic reactions and energy for chemolithoautotrophy. Once the plume samples are returned safely in 2030's, microscopic analyses for returned samples will be conducted, including synchrotron X-ray analyses, chemical and mineralogical analyses with a nano-SIMS, and calorimetry with radioactive isotopic tracers. In order to achieve both sufficiently high encountering velocity for TOF spectroscopy and low velocity for intact capture of the plume particles, the spacecraft needs to either orbit Saturn and fly-by Enceladus or orbit the satellite itself and still is able to return to the earth after the rendezvous phase.

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