

## 火星模擬土壌付着微生物の検出

(東京工科大<sup>1</sup>・JAXA 宇宙研<sup>2</sup>) ○佐々木 聡<sup>1</sup>・國枝 泰希<sup>1</sup>・塩谷 圭吾<sup>2</sup>

Microorganism detection from Mars sand simulant (<sup>1</sup>Tokyo Univ. Technol., <sup>2</sup>ISAS, JAXA)○  
Satoshi Sasaki<sup>1</sup>, Taiki Kunieda<sup>1</sup>, Keigo Enya<sup>2</sup>

When conducting astrobiological exploration, the risk of contamination by Earth-originating organisms should be minimized, while achieving high-sensitivity detection with as lightweight equipment as possible. As targets familiar with the definition of life, we chose ATP, a metabolic product, and DNA, the key substance for self-replication. With Mars in mind, we evaluated a system for quantifying model microorganisms (*E. coli*) attached to Mars sand simulant, using ATP and DNA as indicators. Lower limit of detection and the dynamic range were evaluated. We used Mars Global Simulant MGS-1 (Exolith Lab) as soil simulant, added *E. coli* suspension to it, then the soil simulant with *E. coli* was dried. Various configurations of samples with different *E. coli* density—were prepared together with controls. For ATP detection, ATP extraction reagent and luminescence reagent were added to the sample, and bioluminescence measurement was performed. The result suggests significant detection of ATP for samples with *E. coli* density used in this work.<sup>1)</sup> For DNA detection, PCR experiments were conducted after alkaline heat extraction of the samples, wherein samples with varying amounts of Mars sand simulant were compared, revealed that the simulant interfered with DNA detection.<sup>2)</sup> Both ATP and DNA target detection results were compared with that of previously reported "Life Detection Microscope" method<sup>3)</sup>, and advantages were recognized in our methods.

**Keywords** : Mars sand simulant, ATP, DNA, Life detection

宇宙生命探査ミッションを進める上では、測定対象への地球由来生物混入のリスクを十分念頭に置き、生命の定義と矛盾しない形で、より軽量・小型な装置による計測が求められる。本研究では火星生命探査を意識し、火星模擬土壌に微生物を添加し、その検出を試みた。微生物に含まれる ATP 及び DNA を指標とし、検出下限やダイナミックレンジに関して評価を行った。一定質量の火星模擬土壌 MGS-1 (Exolith Lab) に様々な菌数の大腸菌懸濁液を滴下後、乾燥させたものをサンプルとして使用した。ATP 計測に際し、ATP 抽出試薬および発光試薬を順にサンプルに添加し、一定時間経過後発光強度を計測した<sup>1)</sup>。DNA 計測に際し、同サンプルからの DNA 抽出のために、熱抽出、アルカリ熱抽出、界面活性剤による抽出、等の方法を試みた。抽出後に増幅された PCR 産物の量は抽出方法に大きく依存していた<sup>2)</sup>。

ATP、DNA いずれを指標とした場合でも、従来報告されてきた Life Detection Microscope と比べ良好な検出下限を示した<sup>3)</sup>。従って本手法は、無人探査機への搭載機器の動作原理選択肢として期待されるのみならず、高感度であるがゆえに、地球に持ち帰られた地球外天体サンプルに対しても、有効な分析法となる可能性を有している。

1) Laboratory experiment of ATP measurement using Mars soil simulant: as a method for extraterrestrial life detection. K. Enya, S. Sasaki, *Anal. Sci.* **2022**, 38, 725.

2) A polymerase chain reaction experiment using *Escherichia coli* and Mars sand simulant for detection and analysis of extraterrestrial life. K. Enya, S. Sasaki, T. Kunieda, *Life Sci Space Res (Amst)*. **2024**, 42, 84.

3) Extraterrestrial Life Signature Detection Microscopy: Search and Analysis of Cells and Organics on Mars and Other Solar System Bodies. K. Enya, Y. Yoshimura *et al.*, *Space Sci Rev* **2022**, 218, 49.