Paper ID: 50396
student

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Astrobiology and Exploration (6)

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DIRECT ASTROBIOLOGICAL SAMPLING OF ENCELADUS' SUBSURFACE VENTS FOR THE MICROLIFE INSTRUMENT SUITE

Abstract

The icy moons of the solar system represent the most promising targets for astrobiological exploration. Direct access to the geyser vents of Enceladus would be highly desirable to acquire pristine biological samples. Over the past few decades despite multiple orbital and landed missions to extraterrestrial bodies such as Mars, still relatively little is known about the microbial presence and the biochemical composition. We have examined the possibility of deploying penetrators to Enceladus to target the geyser vents to gain access to pristine or near-pristine subsurface samples. Penetrators are small missile-type entry descent and landing vehicles that can carry modest scientific instruments capable of withstanding impact into the subsurface. The instrumentation used for any biochemical analysis on astrobiological targets such as Mars, Enceladus, should perform experiments with extreme precision and sensitivity such that it does not contaminate the sample and at the same time depicts results with high throughput. We are examining a subset of instruments that might be deployed on such a penetrator based on current work in developing an astrobiological suite of robotic instruments (Micro Life) for Mars rover deployment comprising a micro-assay instrument and a nanopore instrument that works on extreme precision and sensitivity to depict results with high throughput. However, the sample handling drill and the microfluidic "plumbing" are the most demanding aspects regarding miniaturization. A significant amount of research in microfluidics in recent years, involving miniaturization of devices such as pumps, valves, and filters, helps integrate and automate the system at a comparatively lower cost. For the drill, we are exploring a bio-inspired design based on the mechanism of the ovipositor of the wood wasp. For the microfluidics, we are exploring minimizing the sample pre-processing required for the instruments. We are working on a miniaturized automated microfluidic system which is capable of performing detection of a presence of life in the environmental samples at Mars analogue site using a Microfluidic Microbial Activity Micro Assay μ-MAMA and Alamar dye. The system will design, amalgamates an arrangement of low bind microfluidic channels, pump, and micro-assay that will be operated completely via computer control. A miniaturized sophisticated astrobiological instrument suite offers high potential for astrobiological prospecting in highly challenging environments including Europa.

Keywords: Astrobiological exploration; Enceladus; Miniaturized automated microfluidic system, Mars, pristine samples