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DUST UNIFIED SAMPLER TO EXAMINE REGOLITH (DUSTER): A MICROBIAL SAMPLING SYSTEM CAPABLE OF PRESERVING DUST PARTICLES

Abstract

As astronauts will traverse outside of their spacecraft and habitations, their space suits will inevitably become exposed to Martian regolith and dust particles. Upon completion of the extravehicular activity the suit will then be removed exposing the astronauts to the dust particles through inhalation and coat the insides of the habitations with an ultrafine layer dust. Since there is no control measure to clean the exposed suits, it is necessary to fully understand the dust particles and their significance to crew safety. In order to understand the dust particle distribution and characteristics, suitable sampling technologies are needed to collect the dust particles. During September 8th and 9th, 2009 an analog field campaign was conducted at the Johnson Space Center (JSC) Rock Yard (Houston, TX) to explore the feasibility of simultaneous collection and preservation of both biological signatures and dust particles. The campaign employed 2 commercial, off-the-shelf biological instruments, the OMNI 3000 (Evogen, Inc.) and the Bio-Capture 550 (ICX Technologies), a dust generation scenario, and an adapted 3' hose sampling nozzle. Samples (48) were collected (300L/min, 10min) into a phosphate buffer solution each day in both the early morning and late afternoon. Further analyses employing total and intracellular ATP assays, live/dead microbiological analysis (propidium monoazide treatment), and 16S rRNA gene copy number assessment via quantitative polymerase chain reaction (Q-PCR) were conducted. Samples that were obtained during dust generation resulted in a murky, muddy buffer with soil particles present in the bottom of the sampling cartridges. Total microbial populations ranged from 3.18102 – 2.19106 to 4.03102 – 8.14107 16S rRNA copy numbers using the Evogen and Bio-Capture instruments, respectively. Total viable microbes from the Evogen system during the dust generation had a 1-order of magnitude increase (RLU/mL) compared to that of the nominal background air. Likewise, the Bio-Capture samples had a 1 to 2-order of magnitude increase with dust generation and a 2-order increase with the hose addition during dust production. Viable bacteria (RLU/mL) increased by 1 and 0.5 logs with the Evogen and Bio-Capture instruments, respectively during dust generation. PMA treated sample DNA was still PCR amplifiable, suggesting that the dust contained viable organisms.In conclusion, this study provides a proof-of-concept validation that two COTS biological air samplers can be utilized to collect and preserve the physical and biological characteristics of a Mars analogue environment. Further work is necessary to optimize and evaluate the efficacy under multiple conditions and soil matrices.