SEARCH FOR EXTANT LIFE THROUGH HUMAN MISSION ON THE SURFACE OF MARS

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Introduction: NASA Mars missions focus on investigating life in past and present Mars, understanding geological history and climate of Mars, and preparing human mission on the surface of Mars. If Martian extant life exists, then it is expected to be a microorganism due to a high level of radiation and the limited amount of liquid water on surface as well as a high level of carbon dioxide in atmosphere. Through human mission, currently available microbiological sensing technologies on Earth can be implemented on Mars with necessary modification and adjustment to Martian environment which has a high level of radiation on surface and a high level of carbon dioxide in atmosphere as well as a low gravity compared to Earth. Martian extant life may make a home in atmosphere, water, ice, soil, or rock of surface or subsurface.

Atmosphere: Microbes consuming carbon-containing chemicals exist in the in the middle-to-upper troposphere (8–15 km altitude) of Earth, and the proportion of some microbes in atmosphere is higher than in soil and dust.[1] MSL Curiosity's detection of a seasonal methane cycle suggests that microbes may exist in Martian atmosphere, which is composed of 96% carbon dioxide. Currently available technology such as the gelatin membrane filter method can be utilized to detect airborne microbes. [2]

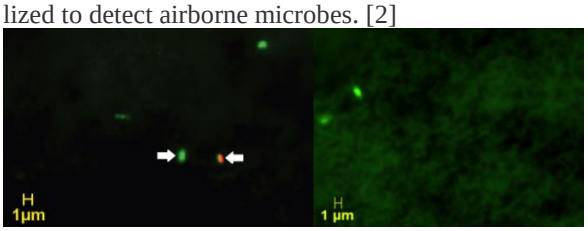

Figure 1. Quantification of bacterial and fungal cells in the high altitudes in Earth atmosphere (Credit: DeLeon-Rodriguez)

Soil and Rock : To detect extant life in soil, technologies such as calorimetry, respirometry, or infrared thermography (IRT), which measures heat produced by microbial respiration, can be utilized.[3] Extant life on rock can be detected by applying fluorogenic substrate analogues.[4]

Ice: Microbes and biomolecules are found in ice deposited in Greenland and Antarctica. Most water on Mars today exists as ice. The similar features between Antarctica and Mars suggest that if extant life exists on Mars, then ice is a good place to harbor microbes. Microbes can studied by scanning electron microscopy.[5]

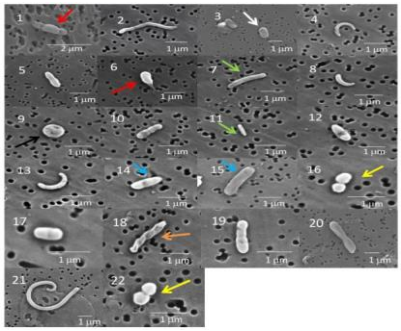

Figure 2. Scanning electron micrographs(SEM) of bacteria found in ice in Greenland and Antarctica (Credit: Knowlton)

Water: Some liquid water may occur transiently on the Martian surface today.[6] Currently available detection techniques of microorganism in water include Biosensors, Vibrational Spectroscopy, MALDI/TOF mass spectrometry, and Adenosine Tri-phosphate assay.[7]

Conclusion: Through human mission, currently available sensing technologies to find microbes in atmosphere, water, ice, soil, rock of surface or subsurface on Earth can be utilized on Mars with necessary modification and adjustment. Direct sampling by astronauts should be minimized in order to reduce the chance to import microbes inside the habitat, which can cause a serious health problem. It is highly recommended that astronauts wear disposable biohazard suits and gloves over spacesuits during EVA, and dispose or sanitize biohazard suits and globes before reentering the habitat.

References: [1] DeLeon-Rodriguez N. et al. (2013) *Microbiome of the upper troposphere: species composition and prevalence, effects of tropical storms, and atmospheric implications* National Academy of Sciences [2] Pendlebury D. et al.(2018) *Examining ways to capture airborne microorganisms* Solid State Technology [3] Kluge B. (2013) *Detection of soil microbial activity by infrared thermography (IRT) Volume 57* Soil Biology and Biochemistry Elsevier [4] Hirsch F.(1995) *Methods for the study of rock-inhabiting microorganisms* Volume 23 Journal of Microbiological Methods Elsevier [5] Knowlton C. et la.(2013) *Microbial analyses of ancient ice core sections from Greenland and Antarctica* .Biology (Basel) [6] *Liquid water from ice and salt on Mars* Geophysical Research Letters (2014) NASA Astrobiology [7]Samendra P. et al.(2014) *Rapid detection technologies for monitoring microorganisms in water* Biosensors Journal