PERMAFROST SAMPLING THE MARTIAN ICE-WATERS USING A SENSOR-BASED ROBOTIC APPENDAGE J. C. Johnson[1,2,3], P. A. Johnson[1,3], and A. A. Mardon[2,3], [1]Faculty of Engineering, University of Alberta (email: jcj2@ualberta.ca), [2]Faculty of Medicine and Dentistry, University of Alberta (email: paj1@ualberta.ca) [3]Antarctic Institute of Canada (103, 11919-82 Str. NW, Edmonton, Alberta CANADA T5B 2W4; email: aamardon@yahoo.ca)

Introduction: While the martian regolith predominates its geography, the permafrost has been receiving growing attention with the speculation of an abundance of subsurface ice. Permafrost is ubiquitous across latitudes on Mars. Viking Mission data indicates the permafrost thicknesses range from 3.5 km at the equator to 8 km at the polar caps. Similar to terrestrial conditions, Ice-I comprises the predominant subsurface ice and is thought to be the predominant water source in permafrost.

Presence of shrouded permafrost ice-water: Spectroscopic data obtained from the Mariner Missions as well as the Viking Landers 1 and 2 [1], which has shown that the absorption spectra of the polar caps were not significantly different from the spectra observed for ordinary ice on earth, has been used to conjecture the presence of water-ice on Mars. In addition, Martian temperatures are cool enough to provide the necessary stability for the permanent presence of water-ice. The gas chromatograph/mass spectrometer data [1] further suggested the presence of water in the soil materials sampled from the Martian surface while the video evidence of the episodic appearance of frost and snow were captured. While a substantial proportion of water remains in an unfrozen state that is distributed throughout the pore space in terrestrial conditions, the proportion of ice to unfrozen water is likely higher due to its dependence on temperature and solute concentration. Considering the tight correlation between the search for water and the search for extraterrestrial life, the drilling, collection, and cultivation of permafrost microorganisms in Mars represents an interesting avenue of exploration.

Microorganism Sampling: While the survival of microorganisms over extended time periods may be curbed by ionizing radiation-induced damage to chromosomal DNA, studies completed in Siberian permafrost on microbial strains of *Psychrobacter cryohalolentis* and *Psychrobacter arcticus* have revealed that this may not be the case on Mars. The presence of perchlorates in the regolith, silicates in Martian dust, and heavy radiation make the discovery of organisms highly unlikely. Nevertheless, ancient permafrost could still represent a historical sink for micro-organic life. If so, sampling areas such as the cratered southern highlands between 60 and 80°S at about 180°W indicates an area considered to be the oldest, best preserved ice-rich permafrost on Mars.

Model for Permafrost Sampling Tool: While Smith and McKay (2005) have extensively described models for aseptic drilling, this is described with the outdated assumption that the organisms that may have once existed are dead by radiation. However, supposing that life still exists, we propose a novel way to detect signatures of life that have been developed for the regolith that could be extended to these areas.

A series of sensors have been used for microorganism detection. Coupled with traditional chemicals employed for the detection of signatures of life, Kasas *et al.* has designed sensors to detect the nano-vibrations created by the metabolic activities of microorganisms. While operations based on core drilling are essential noting the pure depth of theses caps, more precision-based excavation requires more controllable, maneuverable tools that incorporates such sensors. Here, we propose the development of a robotic arm that can integrate these sensors and be used in conjunction with the drill. This can enable excavators to tap into various other methodologies for sampling including borings, test pits, and natural exposure sampling.

The basic specifications for the robotic appendage would be similar to other remote manipulation systems such as the Canadarm. Specifications for the sensor terminus include 1) a cantilever array that contains several different sensors paired with corresponding linker molecules; 2) a suitable sample loading mechanism and preservation capsule; 3) matched physical properties of the cantilever (i.e. spring constants) to match the gravitational field of Mars.

References:

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