Challenges and solutions for the human exploration of the Martian poles

Conference or Workshop Item

CHALLENGES AND SOLUTIONS FOR THE HUMAN EXPLORATION OF THE MARTIAN POLES.

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Introduction: The Martian poles present special challenges for human scientific expeditions that bear similarities to operations in terrestrial polar regions. These challenges include mobility on snows and ices, the problem of accommodation in the deep field, methods for the use of local resources and problems of station maintenance. Because the polar regions are dynamic, substantial volatile sinks, the exploration of the polar regions by humans is a potentially high priority exploration goal. Furthermore, the high astrobiological potential of these regions makes them attractive targets for human exploration.

The exploration of the Martian poles might begin in the earliest stages of a human presence on the planet or missions of exploration might be launched from lower-latitude stations that would avoid the 9-month 24 hr darkness of polar winter, which imposes substantial long-term safety problems.

Mobility: I describe a series of concepts in response to these challenges [1-3]. Mobility on Martian snows and ices can be achieved with pressurized tracked rovers or unpressurized skidoos using methane or other fuels readily made from CO_2 and H_20, both abundantly available at the poles. Materials and supplies can be carried by Nansen sledge in an analogous way to Earth. By heating the underside of the sledges, a sublimed vapor layer can be used to assist in mobility and reduce the chances of freezing to the polar substratum ('polar hover').

Field stations: Field stations, depots and deep-field sites can be realized with pressurized 'ball' tents that allow two scientists to rest within a pressurized, heated environment. Larger versions of such easily assembled stations ('ball field stations') can be used for emergencies and the establishment of short-term camps on the polar ice caps. An augmentation of the ball tent is the Migloo - Martian igloo assembled from a pressurized tent surrounded with blocks of ice that can be used as a Solar Particle Event shelter, the ice reduces the radiation flux. These structures may also find use in deploying robust depots across the polar caps.

In-situ resourse use: Liquid water for drinking and for fuel and oxygen production can be gathered from the poles by two means – either 1) subliming the ice and snow by heating it and gathering the vapor for use in various manfacturing processes. This can be achieved with innovations such as 'sublimation netting' (Figure 1), a network of hollow, heated fibres that heat the ice and snow and draw it into a vacuum system or 2) pressurizing blocks of cut snow and ice and then heating directly into a liquid state, thus avoiding the cost of the latent heat of vaporisation.

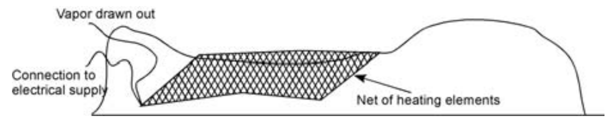

Figure 1. Sublimation netting can be used to gather water for in-situ resource utilization at the Martian poles.

Trans-polar assaults: As well as scientific exploration at specific points on the polar caps, future expeditions might be launched as exploratory trans-polar expeditions across the Martian poles. These expeditions would gather samples across a polar transect and complete traverses that in distance are similar to Trans-polar Antarctic expeditions. I discuss operations at the Martian poles during the 24 hr darkness of polar winter and the challenges presented to overwintering operations.

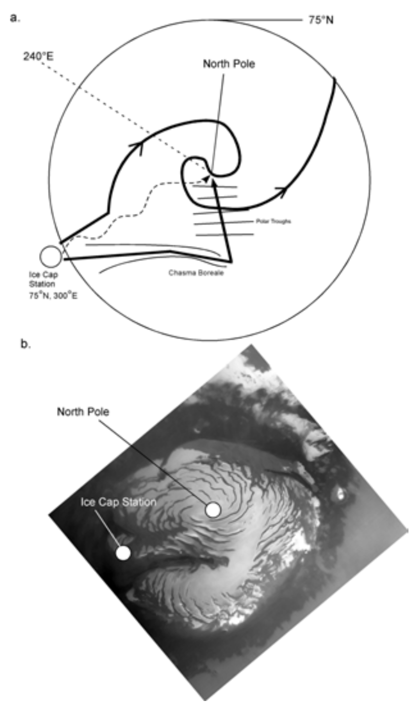

Figure 2. Trans-polar expeditions provide opportunities for polar sampling and purely exploration-driven assaults.

References: [1] C.S. Cockell, (1995) *JBIS*, 48, 359-368. [2] C.S. Cockell, (2001) *Acta Astronautica*, 49, 693-706. [3] C.S. Cockell and A.A. Ellery, (2003) *JBIS*, 56, 33-42.