PERIODIC HABITABILITY IN NORTHERN PLAINS GROUND ICE: THE ICEBREAKER LIFE MISSION PLAN. C. Stoker[1], C. McKay[1], A. Davila[1] , B. Glass[2], V. Parro[3], [1] Space Science Division, NASA Ames Research Center, Moffett Field CA, [2]Exploration Technology Division, NASA Ames Research Center, Moffett Field CA, [3]Centro de Astrobiología (INTA-CSIC), Madrid, Spain

Introduction: The results from the 2008 Phoenix mission that sampled ground ice at 68^{o}N latitude, along with climate modeling studies, indicate that the high N. latitude ice-rich regolith at low elevations is likely to be a recently habitable place on Mars [1].

Habitable Conditions Evidence: Ice was found within 3-5 cm of the surface. If warmer conditions occur, the ice could provide a source of liquid water. Phoenix found evidence for liquid water processes including 1) beneath 3 -5 cm of dry soil, segregated pure ice was discovered in patches covering 10% of the area explored, 2) calcite mineral was detected in the soil, 3) varying perchlorate salt concentrations were observed with higher concentrations seen in soil clods [2]. Carbon dioxide and nitrogen in the atmosphere, and nitrates in the soil along with reduced iron and perchlorate salts in the soil provide carbon and energy sources, and oxidative power to drive chemoautotrophic metabolism. Search for organics was a mission objective but perchlorate, discovered by Phoenix [3], would have oxidized any organic carbon during the heating step in the Thermal Evolved Gas Analysis (TEGA) instrument. Variations in solar insolation associated with changes in the season of perihelion on 25kyr timescales and obliquity variations on 125kyr timescales [4] cause warmer and colder periods in the N. polar region. The current epoch is colder than normal because orbital tilt is low and summer occurs at apehelion. As recently as 17kyr ago, when summer solstice was at perihelion, climate models show temperatures were warm enough to allow pure liquid water to form [5]. At orbital tilts > 35^o, insolation is equivalent to levels experienced in Earth's polar regions at the present time. At 45^o temperatures above -20°C can persist to 75 cm depth for durations long enough to allow microbial growth [6].

Terrestrial permafrost communities are an example of possible life in the ice-rich regolith. Studies in permafrost have shown that microorganisms can function in ice-soil mixtures at temperatures as low as -20°C, living in the thin films of interfacial water [7]. In addition, it is well established that ground ice preserves living cells, biological material, and organic compounds for long periods of time, and living microorganisms have been preserved under frozen conditions for thousands and sometimes millions of years[8]. Smilar biomolecular evidence of life could have accumulated in the ice-rich regolith on Mars.

The Mars Icebreaker Life mission [9] was proposed to Discovery in 2015 to search for evidence of modern life in northern plains ground ice on Mars, and future proposals are planned. The mission returns to the well-characterized Phoenix landing site with a payload designed to address the following science goals: (1) search for biomolecular evidence of life; (2) search for organic matter from either exogeneous or endogeneous sources using methods that are not spoiled by the presence of perchlorate; (3) characterize oxidative species that produced reactivity of soils seen by Viking; and 4) assess the habitability of the ice bearing soils. The Icebreaker Life payload hosts a 1-m drill that brings cuttings samples to the surface where they are delivered to three instruments. The Signs of Life Detector (SOLID) [10] uses immunoassay to search for up to 300 biomolecules that are universally present and deeply rooted in the tree of Earth life. The Laser Desorption Mass Spectrometer (LDMS) [11] performs broad search for organic compounds of low to moderate molecular weight that may be cosmogenic in origin or degraded biomolecules. The results are not impacted by the presence of perchlorate. The Wet Chemistry Laboratory (WCL) [3] detects soluble species of potential nutrients and reactive oxidants, providing insight into the habitability potential of icy soils.

The Icebreaker payload fits on the same spacecraft/ lander used by Phoenix. The mission plan that fits in a Discovery budget profile proves that a search for modern life on Mars can be performed for modest cost while conforming to planetary protection constraints.

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