THE ICEBREAKER MARS MISSION: SEARCHING FOR EVIDENCE OF LIFE.

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Introduction: Icebreaker is a proposed Discovery Class mission [1] that plans to return to the Phoenix site on Mars, an environment that was once habitable in recent times [2]. Icebreaker (Fig 1) will drill up to 1 meter collecting and analysing samples searching for bio-molecules, organics, and evidence of soil reactivity and habitability (Carbon, Hydrogen, Nitrogen, Oxygen & Sulfur) and metabolic redox species.

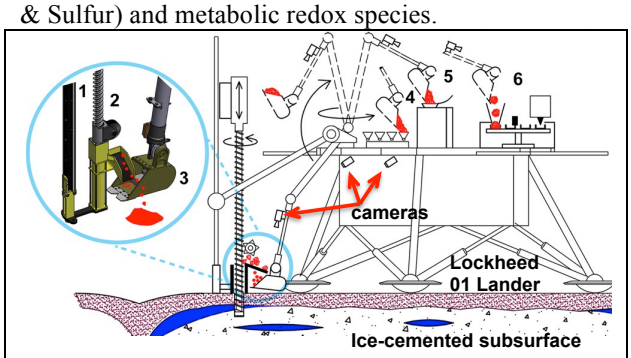

Figure 1: Aquiring samples: The drill augers cuttings that rise up the drill string flutes (1); are swept off by the brush (2); sifted and captured by robot arm scoop (3). The scoop then dumps sample into the instrument inlets (WCL 4, SOLID 5 & LDMS 6).

Martian Life hypothesis: A key hypothesis is that Mars and Earth have exchanged of biology [3] as a result of meteoritic impacts. Thus today, Earth and possible Mars biology may have similar key DNA, ATP and Lipid molecular structures, as these have remained unchanged on Earth since the earliest forms of life. Icebreaker's bio-molecule detector, SOLID, looks these key Earth-like bio-molecules using Fluorescence Sandwich Immunoassays [4]. If Mars life is different than Earth life (a second genesis) it will be difficult to confirm since there are no known Earth analogs for these bio-molecular structures.

The Phoenix landing site habitability: The Phoenix landing site has near surface ground ice and at low elevation has high atmospheric pressure allowing liquid water in warm conditions. Warm periods occur in 125 Kyr intervals (Fig 2) when Mars obliquity is high [5]. At 33° obliquity, water melts at 36 cm depth and at 45° obliquity, metabolism (for Earth microbes) could occur at 75 cm depth at - 20° C.The recent past (> 3.5 Mya) was warmer and more habitable than today. Cosmic radiation sterilizes dormant biology after 0.5 Myr [6], but the warm intervals enables biology to repair damage, multiply, and recover.

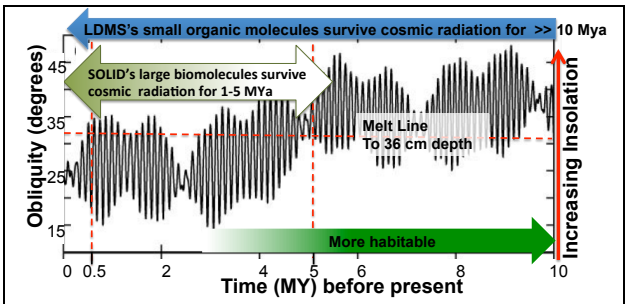

Figure 2: Dormant life repairs at High Obliquity. SOLID can detect cosmic ray damaged bio-molecules to 5 Mya [7] and LDMS organics till >>10 Mya

The Payload & spacecraft (Fig 1): The instruments are: 1) The Signs of Life Detector (SOLID) from the Centro de Astrobiologia in Spain [4]; 2) The Laser Desorption Mass Spectrometer (LDMS) from The Goddard Space Flight Center [8]; and, 3) The Wet Chemistry Laboratory (WCL) from the Jet Propulsion Laboratory [9]. Sample handling consists of a Drill [10], Scoop [11] and LDMS Carousel from Honeybee Robotics, and Robot Arm from MacDonald Dettwiler & Associates in Canada [11]. The Image system (IIS) is from Malin Space Science Systems. The spacecraft is the Lockheed 01 Lander, near identical to InSight.

Planetary Protection and contamination control: Icebreaker complies with NASA's Planetary protection requirements but also any life positive results must withstand scientific scrutiny for the mission to be a success. Thus contamination management is very significant part of mission planning.

Conclusion: Icebreaker searches for evidence of Earth-like life on Mars and maps subsurface organics and chemistry assuming that Mars and Earth have exchanged biology. If successful Icebreaker could be scientifically "game changing".

References: [1] McKay C.P (2013) Astrobiology Vol 13, No 4, 334-352, [2] Stoker, C.R. (2010) JGR: Planets (1991–2012), [3] Melosh, H.J. (1998) Nature 332 .6166: 687-688, [4] Parro, V. (2011) Astrobiology 11:15–28, [5] Zent, A. (2008) Icarus 196:385–408, [6] Dartnell, L.R. (2007) GR Letters 34 .2, [7] Parro, V. (2015) 46th LPSC, [8] Brinckerhoff W. (2014) 45th LPSC, [9] Kounaves S.P. (2010) JGR Vol 114, [10] Zacny, K. (2013) Astrobiology 13 .12 1166-1198, [11] Bonitz, R.G. (2008) JGR: Planets (1991–2012)