THE ICEBREAKER MARS MISSION TECHNOLOGY: SEARCHING FOR EVIDENCE OF LIFE.

D. Willson[1], C. P. McKay[1], C. R. Stoker[1], B. J. Glass[1], A. Dave[1], A .F. Davila[2], R. C. Quinn[2], V. Parro[4], K. Zacny[5], E. Z. Noe[1], M. Abraham[1], H. D. Smith[1] and the Icebreaker team.
[1]NASA Ames Research Center, Moffett Field CA 94035, Email david.willson@nasa.gov, [2]Carl Sagan Center at the SETI Institute. 189 Bernardo Ave., Suite 100. Mountain View, CA 94043-5203, [4]Centro de Astrobiología (INTA-CSIC), Carretera de Ajalvir km4, Torrejón de Ardoz, Madrid Spain, [5]Honeybee Robotics 398 W Washington Blvd, Suite 200, Pasadena, CA, 91103,

Introduction: The proposed Icebreaker Discovery Class mission [1] plans to return to the Phoenix site on Mars which was once habitable in recent times [2]. Icebreaker (Fig 1) will drill up to 1 meter collecting & analysing samples searching for bio-molecules, organics, and evidence of soil reactivity and habitability.

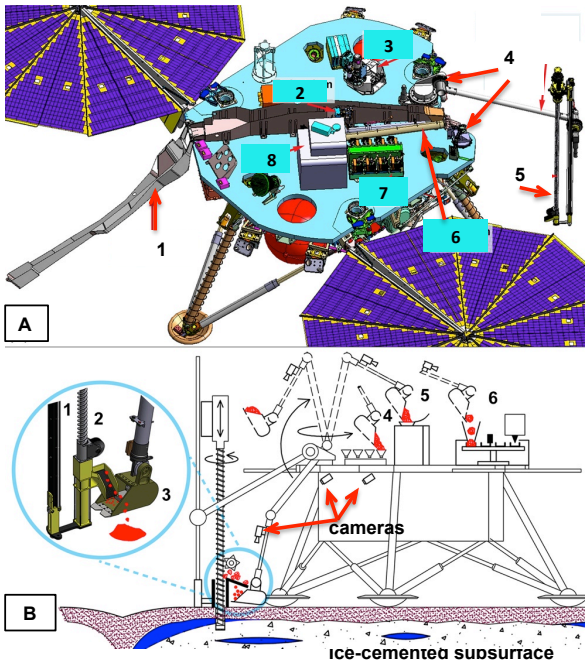

Figure 1: (A) Payload arrangement: (1) Drill biobarrier opened, (2) Robot arm camera, (3) LDMS & Carousel, (4) Deck cameras, (5) Deployed drill, (6) Stowed Robot Arm, (7) WCL, (8) SOLID.
(B) Sample handling system (SHS): The drill augers cuttings that rise up the drill string flutes (1); are swept off 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).

The Payload & spacecraft (Fig 1): The instruments are: 1) The Signs of Life Detector (SOLID) from the Centro de Astrobiologia, Spain; 2) The Laser Desorption Mass Spectrometer (LDMS), Goddard Space Flight Center; 3) The Wet Chemistry Laboratory (WCL), Jet Propulsion Laboratory, and 4) The Image system (IIS), Malin Space Science Systems. The SHS (refer Fig 1B & Table 1) is a Drill, Scoop and Carousel from Honeybee Robotics, and Robot Arm from Mac-Donald Dettwiler & Associates, Canada. The Lockheed Martin 01 Lander, is near identical to InSight.

Table 1: Instruments, Lineage and Functions

Instrument ***Lineage***	**Function**
SOLID [3] *Mars chamber*	Detects selected bio-molecules of up to 100,000s Da.
LDMS [4] *ExoMars*	Detects and characterizes smaller non-volatile organics 20-1000 Da.
WCL [5] *Phoenix*	Quantifies soluble aqueous components (salts and oxidants). Characterizes life energy sources/nutrients.
IIS *OSIRIS REX*	3 cameras monitoring drilling, sample acquisition and delivery.
Drill [6] *Mars chamber*	Single string rotary percussive, 1 m depth drill. Provides cuttings.
Robot Arm [7] *InSight*	4-DOF robotic manipulator arm transfers samples to instruments
Scoop [7] *Phoenix*	Active ejection scoop
Carousel/ *MSL*	Positions/levels sample for LDMS

Detecting evidence of life: Mars and Earth may have exchanged of biology [8] due to meteoritic impacts. Thus today, Earth and possible Mars biology may have similar key DNA, ATP & Lipid molecular structures which have not changed since early life. SOLID, captures these key Earth-like bio-molecules using Fluorescence Sandwich Immunoassays [3].

Planetary Protection and contamination control: Mission success requires Icebreaker to comply with NASA's Planetary Protection Policy (NPR 8020 12D) but also must withstand scientific scrutiny if life positive results are found. Icebreaker is category IVb & IVc. Thus elements contacting the subsurface (drill string) must be sterilized to prevent forward contamination, and elements contacting samples (SHS & SOLID) must be cleaned below detectability to prevent false positive results. The drill, Robot Fore-arm with Scoop are cleaned, sterilized and located in bio-barriers. SOLID is cleaned and sealed.

References: [1] McKay C.P (2013) Astrobiology Vol 13, No 4, 334-352, [2] Stoker, C.R. (2010) JGR: Planets (1991–2012), [3] Parro, V. (2015) 46th LPSC, [4] Brinckerhoff W. (2014) 45th LPSC, [5] Kounaves S.P. (2010) JGR Vol 114, [6] Zacny, K. (2013) Astrobiology 13 .12 1166-1198, [7] Bonitz, R.G. (2008) JGR: Planets (1991–2012) [8] Melosh, H.J. (1998) Nature 332 .6166: 687-688