MARTIAN SUBSURFACE ICE SCIENCE INVESTIGATION WITH A SPECIAL REGIONS DRILL. J. L. Eigenbrode[1] B. Glass[2], C. P. McKay[3], P. Niles[4] and J. A. Spry[5], [1]NASA Goddard Space Flight Center, Solar System Exploration Division, Code 699, Greenbelt, MD 20771 USA, Jennifer.L.Eigenbrode@nasa.gov, [2]NASA Ames Research Center, Intelligent Systems Division, Moffett Field, CA 94035. Brian.Glass@nasa.gov, [3]NASA Ames Research Center, Planetary Systems Branch, Code SST, Moffett Field, CA 94035, Christopher.P.McKay@nasa.gov, [4]NASA Johnson Space Center, Astromaterials Research and Exploration Directorate, Mail Code KR, Houston, TX 77058, Paul.B.Niles@nasa.gov, [5]SETI Institute, 189 Bernardo Ave, Mountain View , CA 94043 and NASA Headquarters OPP, 300 E. Street SW, Washington, DC 20546, James.A.Spry@nasa.gov.

Introduction: Subsurface water ice is a fundamental unexplored record of Mars that is expected to provide key insights into past and present near-surfaces processes that influence both surface and atmospheric conditions on regional to planetary scales. Such science investigations will access, sample, and measure the physical and chemical conditions of the subsurface, will yield significant science returns and would address questions that are not possible with surface investigations. We propose an astrobiology mission concept that aims for due diligence in the search for extant life on Mars [1].

Importantly, subsurface ice is an accessible, possible abode for extant life on Mars. It has been a target for exploration by astrobiologists for decades. In situ, robotic access to pristine subsurface ice will enable evaluation of its indigenous biological potential before human presence.

Drilling: In order to drill subsurface ice and support science measurements, we need to know where ice is accessible at scales relevant to sampling (less than or equal to 1 m resolution) before drilling. Doing so, mitigates the risk of dry holes. Accessible-ice mapping might be accomplished by remote and/or in situ prospecting. Further, drilling must be robotic because a direct human presence would pose an inadvertent and high contamination risk to science [2]. Drilling could be accomplished with an auger-type drill that provides sample "bites" for science measurements. As such, coring would not be required to meet science requirements. Auger drilling is a well-established technology for applications on Earth. ESA's ExoMars 2020 rover will be the first spacecraft to drill the subsurface on Mars.

During subsurface ice drilling, some ice is expected to melt. As a consequence, drilling will create a "spacecraft-induced Special Region". The drill will be a Special Regions drill, which means it would need to meet requirements for a planetary protection category IVc mission; however, any intent to search for life signature in borehole samples would heighten the mission classification to category IVb. Both planetary protection requirements and science integrity will demand a high level of bioburden and biomolecular contamination control.

A mission requirement would be to confirm the distribution and nature (massive ice, ice cement, or mineral hydration) of subsurface water in collected samples as compared to that detected by remote or prospecting instruments. Doing so will support modeling that may extend science insights into climatic and geohydrologic processes.

Science Requirements: The prime science goal of an astrobiology mission targeting subsurface ice would be to search for signs of life, particularly extant life (or cryogenically, well-preserved ancient life). Multiple and independent measurement types are needed for determination of whether life is present. A second objection, assuming life presence is indicated, would be to test if it has Earth-like biochemistry. Other objectives strive to build an understanding of subsurface ice habitability or ecology and they include measurements of general oxidant, organic, and solution (pH, eH, δD, $\delta^{18}O$, ions) chemistry, and perhaps bioavailable elements (CHNOPS, metals) and radioactive isotopes for dating materials and processes.

Samples for in situ measurements must include samples below tolerable radiation dose rates for Earth-like organisms, i.e., below the "critical depth" (CD), currently assessed at 1.5-2.5 m depending on model variables [3-5]. The threshold mission requires 2 drill holes at a single sampling location, 4-6 samples per hole, with at least one sample per hole from below the CD. The baseline mission requires 2-3 drill holes from each of 2-3 geological sampling locations, 8-12 samples per hole, with at least two samples per hole from at or below the CD.

The mission concept presented here is motivated by science interests but such an investigation would also support objectives to determine resource availability and hazards for humans.

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