RATIONALE AND CONCEPT FOR A SYNTHETIC APERTURE RADAR AND SUB-SURFACE ICE SOUNDER FOR MARS. G. R. Osinski[1,2], A. Baylis[3], I. Barnard[3], P. Allen[3], R. Caves[4], E. Cloutis[5], P. Fulford[6], J. B. Garvin[7], J. W. Holt[8], D. Lacelle[9], C. D. Neish[1], B. Rabus[10], M. Schmidt[11], J. Sharma[4], R. J. Soare[12], L. L. Tornabene[1], A. Thompson[4], [1]Centre for Planetary Science and Exploration / Dept. of Earth Sciences, University of Western Ontario, ON, Canada, [2]Dept. of Physics and Astronomy, University of Western Ontario, ON, Canada, [3]MDA Corporation, Sainte-Anne-de-Bellevue, QC, Canada, [4]MDA Corporation, Richmond, BC, Canada, [5]Dept. of Geography, University of Winnipeg, MB, Canada, [6]MDA Corporation, Brampton, ON, Canada, [7]NASA Goddard Space Flight Center, MD, USA, [8]Institute for Geophysics and Dept. of Geological Sciences, University of Texas at Austin, TX, USA, [9]Dept. of Geography, University of Ottawa, ON, Canada, [10]School of Engineering Science, Simon Fraser University, BC, Canada, [11]Dept. of Earth Sciences, Brock University, Canada, [11]Dept. Geography, Dawson College, Canada (gosinski@uwo.ca).

Introduction: A wealth of mission data has provided insight into the current distribution of H_2O on Mars. Data from the gamma ray spectrometer (GRS) onboard the Mars Odyssey spacecraft indicates that the upper ~1 m of the Martian surface contains an extensive amount of ground ice at latitudes >40–50° [1]; direct observations from the Phoenix lander confirmed these observations at a single location [2]. Subsurface radar sounding of glacial landforms using the SHARAD instrument suggests that water ice may be present depths of 10s to 100s metres (e.g., [3, 4]).

Despite the large number of missions and huge number of studies, *there exists a fundamental gap in our knowledge about the distribution and amount of ice present at depths of >1 m to ~10 m on Mars.* This is mirrored by the findings of the Final Report of the MEPAG Next Orbiter Science Analysis Group (NEXSAG). The report concludes that a "Polarimetric radar imaging (SAR) with penetration depth of a few (<10) meters" was critical for addressing the resource, science, and reconnaissance objectives of the Next Mars Orbiter (NeMO) mission.

In April 2017, MDA Corporation began a Concept Study for a Sub-Surface Ice Sounder for a future Mars orbiter under contract from the Canadian Space Agency (CSA). The Concept Study team comprises a Technical Team (Technical Lead: I. Bernard) and a Science Team (PI: G. R. Osinski) led by Program Manager A. Baylis. In this contribution we provide an overview of the concept as it stands, discuss open questions, and welcome feedback and involvement from the international planetary science community.

Science objectives: For the purposes of this Concept Study, the Science Team has defined the following 5 science objectives: 1) Determine the overall spatial and vertical distribution of shallow ground ice deposits in the Martian mid- to high-latitudes; 2) Characterize the properties of the upper portion of the polar layered deposits; 3) Map and quantify shallow ground ice in areas of possible brine flow and monitor for recent RSL and gully formation activity; 4) Detect, characterize and map exposed and buried fluvial landforms in ancient Martian terrains; 5) Determine the surface properties of impact and volcanic deposits.

Requirements for radar instrument: In the following sections we outline the current status of the instrument requirements. It is important to note that these are draft and the concept is still evolving.

SAR Imaging Mode. The science goals specified above can be met with a polarimetric Strip-map approach, in general. The science objectives identify the imaging characteristics of the radar in terms of high resolution (2–3 m), medium resolution (~5–7m) and low resolution (<15 m). In these different modes, the desirable coverage of the instrument in a nominal 687day mission is: ~0.5 % of Mars in HR mode; ~5% of Mars in MR mode with repeat coverage by seasons; ~35% of Mars in LR mode with repeat coverage by seasons. A range of incidence angles from ~30 to 50 degrees and both fully polarimetric (quad-pol) and compact-pol options are currently being considered.

SAR Sounder Mode. The current configuration is for a nadir looking sounder mode with vertical resolution of 1 m and along track sampling of <50 m. The target is >60% coverage in this mode.

Operating frequency. Previous studies [5] have largely considered P-band radar operating at ~500 MHz and < 1 GHz. Various options including a P-band radar (~500 mHz centre frequency), an L-band radar (~1.1 GHz) and a dual frequency solution are being studied by the instrument team.

Future work: This concept is the focus of ongoing work. We welcome input from the community.

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