HOMER: A SMALLSAT GROUND PENETRATING RADAR SOUNDING FLEET TO MAP PLANETARY SURFACES AT HIGH RESOLUTION. D. M. Persaud[1], T. S. Wu[2], J. Tarnas[3], M. Preudhomme[4], M. Jurg[5], C.Chalumeau[6], H. Buckley[7], and N. Lombard-Poirot[8], [1]University of Rochester, Rochester, NY [2]NASA Ames Research Center, Moffett Field, CA [3]Wesleyan University, Middletown, CT, [4]NASA JPL, [5]Monash University, Melbourne, Australia, [6]ISAE-SUPAERO, Toulouse, France, [7]University of Southern California, Los Angeles, CA, [8]Case Western Reserve University, OH.

Introduction: The Martian surface remains hostile due to a lack of atmosphere, temperature variability, and solar radiation, but its subsurface holds promise for present or ancient astrobiology and future human habitation. The location and characterization of near-surface (< 100 m) ice distributions and lava tube (pyroduct) systems could provide both valuable geological and astrobiological insight, and a basis for accessing these in situ resources.

To detect and analyze the near Martian subsurface from orbit, a novel compact approach called the High-resolution Orbiter for Mapping gEology by Radar (HOMER) is here proposed, and a mission design, including potential target regions on Mars, proposed hardware, and future objectives, is presented. HOMER combines ground penetrating radar (GPR), synthetic aperture radar, (SAR), and tomography in a five-unit small satellite sounding fleet, to achieve theoretical 3D resolution of 50 m from low-Mars orbit (LMO). Though designed for a Martian mission, the HOMER design could be easily adapted to a wide variety of planetary bodies.

Science Objectives: The HOMER mission objective is to detect and characterize near subsurface ice distributions and pyroduct systems on Mars at < 50 m 3D resolution. Radiation and thermal protection are major elements of pyroduct importance to astrobiology and human space exploration, and these systems are considered potential targets for manned missions and astronaut habitation [1]. Furthermore, it is argued that current subsurface ambient Martian conditions can host environments favorable to microbial 'extremophiles' [2]. Characterization of subsurface ice distribution on Mars would enable detailed study of Martian hydrological history, in addition to evaluation of resources for both astrobiology and humans. Using GPR, we can precisely characterize this distribution as well as the location and thickness of the ice table.

The target regions of Elysium Mons and the Tharsis Montes have been selected for HOMER based on HiRISE detection of collapsed pyroduct systems, and possible ancient interaction between proposed shorelines and lava flows. This region has long been considered as potentially recently hydrous based on regional concentrations of hydrogen and chlorine [3], and the chemistry of this interface is considered potentially favorable to astrobiology [4]. Cave systems are also considered likely to hold clean-ice deposits [5].

Hardware: HOMER consists of a fleet of five identical ground-penetrating radar (GPR) smallsat units and a single larger mothership. During interplanetary transport, the smallsat units are held in a secondary payload bay of the mothership; data collection begins after these units are deployed by the mothership into unique 400 km circular Martian orbits, with inclinations ranging equipunctually from 0 to 40 degrees. The mothership acts as a communications relay back to Earth for the duration of the mission. Inter-unit and unit-to-mothership is achieved by 100 MHz radar telemetry.

During data collection, each identical smallsat unit will, at discrete times, transmit (TX) or receive (RX) signal at 100 MHz with a 40 MHz bandwidth. A single unit will transmit a GPR signal, while the remaining four units receive this signal in passive mode, simultaneously repurposing transmission power unused in passive mode to process and transmit data to the mothership. This TX/RX duty will cycle rapidly between all units during the entire collection period. The resulting multiple-perspective, simultaneous datasets will be correlated by tomography and possibly interferometry to create a coherent image of the martian subsurface, possibly enabling on-board processing and clearer GPR data interpretation. Theoretical calculations suggest up to 45 m penetration depth, and 0.25 x 17 x 1.7 m 3D resolution.

The HOMER mission addresses NASA 2015 Technical Roadmap Objectives (6), (7.1), and (8.1).

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