MID-LATITUDE MARTIAN ICE AS A TARGET FOR HUMAN EXPLORATION, ASTROBIOLOGY, AND IN-SITU RESOURCE UTILIZATION. D. Viola[1] (dviola@lpl.arizona.edu), A. S. McEwen[1], and C. M. Dundas[2]. [1]University of Arizona, Department of Planetary Sciences, [2]USGS, Astrogeology Science Center.

Introduction: Future human missions to Mars will need to rely on resources available near the Martian surface. Water is of primary importance, and is known to be abundant on Mars in multiple forms, including hydrated minerals [1] and pore-filling and excess ice deposits [2]. Of these sources, excess ice (or ice which exceeds the available regolith pore space) may be the most promising for in-situ resource utilization (ISRU). Since Martian excess ice is thought to contain a low fraction of dust and other contaminants (~<10% by volume, [3]) only a modest deposit of excess ice will be sufficient to support a human presence.

Subsurface water ice may also be of astrobiological interest as a potential current habitat or as a preservation medium for biosignatures. Permafrost on Earth is a known habitat for cryophilic terrestrial organisms [e.g. 4], and it is possible that the subsurface ice on Mars could contain extant or recently extinct Martian microorganisms at depth within the ice.

We propose two Exploration Zones (EZ) in the northern mid-latitudes of Mars in the vicinity of Arcadia and Amazonis Planitiae. These regions are thought to contain abundant subsurface excess ice within the uppermost meter of regolith that has been present for >20 Myr [5]. This ice can be considered both a science and ISRU region of interest (ROI) as described above, and is the primary motivation for proposing these sites. The uppermost surface at both of these locations is also fairly rich in iron and silicon (14 and 18-20 wt. % respectively, [6]), which are also of interest for ISRU. Additional science ROIs for each specific EZ are discussed below and can be found in Figures 1 and 2.

Erebus Montes: This proposed site is centered near 192.1°E, 39.0°N (Fig. 1). The central landing site is located within Amazonian lava flows, and provides access to two different exposures of Hesperian-Noachian transition terrain [7]. The region contains evidence for glacial and periglacial landforms such as ice-altered secondary craters [5] and ice-rich lobate debris aprons [8]. Furthermore, a recent ice-exposing impact was identified within this EZ [9]. These are all strong indications of accessible subsurface excess water ice and represent locations of interest for future study. The nearby exposures of Noachian-Hesperian transition unit are also of scientific interest, providing the opportunity to study ancient rocks within the context of the surrounding Amazonian lava flows.

Acheron Fossae: This proposed site is centered near 220.6°E, 39.8°N (Fig. 2). Acheron Fossae is a region of late Noachian highlands terrain, and is comprised of a series of grabens and ridges surrounded by later Hesperian/Amazonian lava flows from the Tharsis region [7]. The proposed landing site is within these lava flows (HAv), and provides access to a region of late Hesperian lowlands in the western region of the EZ. There is evidence for Amazonian glacial and periglacial activity [e.g., HiRISE images PSP_008671_2210 and ESP_017374_2210], and the Gamma Ray Spectrometer water map suggests that there is abundant subsurface ice in the uppermost meter within this region [10]. Meandering channel-like features have been identified in HiRISE images (e.g., PSP_003529_2195 in close proximity to apparent ice flow features), suggesting possible past sub-ice water flow. Material interpreted as rock glaciers has been observed on the floors of the grabens [11], which may also be of interest for future study since they are found throughout the northern and southern mid-latitudes.

Advantages as Landing Sites: Both of these sites are at low elevations (-3.98 and -3.15 km) to facilitate Entry, Descent, and Landing with large atmospheric masses and greater radiation shielding. The terrains are quite flat at the scale of both MOLA and HiRISE DTMs. There are few meter-scale hazards in most HiRISE images. Multiple 25 km^2 landing sites appear to be acceptable. They are at the lowest latitudes at which we currently know that shallow ice is present, minimizing thermal challenges. HiRISE images indicate that loose regolith is available for construction purposes.

Potential Challenges: Both of the regions proposed here are moderately dusty (typical thermal inertia values for Erebus Montes and Acheron Fossae are 120-130 and 60-90 $Jm^{-2}K^{-2}sec^{-1/2}$, respectively), which may prove to be a challenge for future human exploration. Dust also obscures the ability of spectroscopic instruments to determine the composition of underlying rocks, which makes it difficult to acquire mineralogic data in these terrains from orbit. However, we have hypothesized that this dust may serve to insulate the subsurface ice against sublimation loss, allowing it to remain stable in large quantities within the shallow subsurface of Arcadia Planitia [5]. The two sites proposed here attempt to minimize surface dust based on the TES Dust Cover Index while remaining within regions thought to contain abundant subsurface ice.

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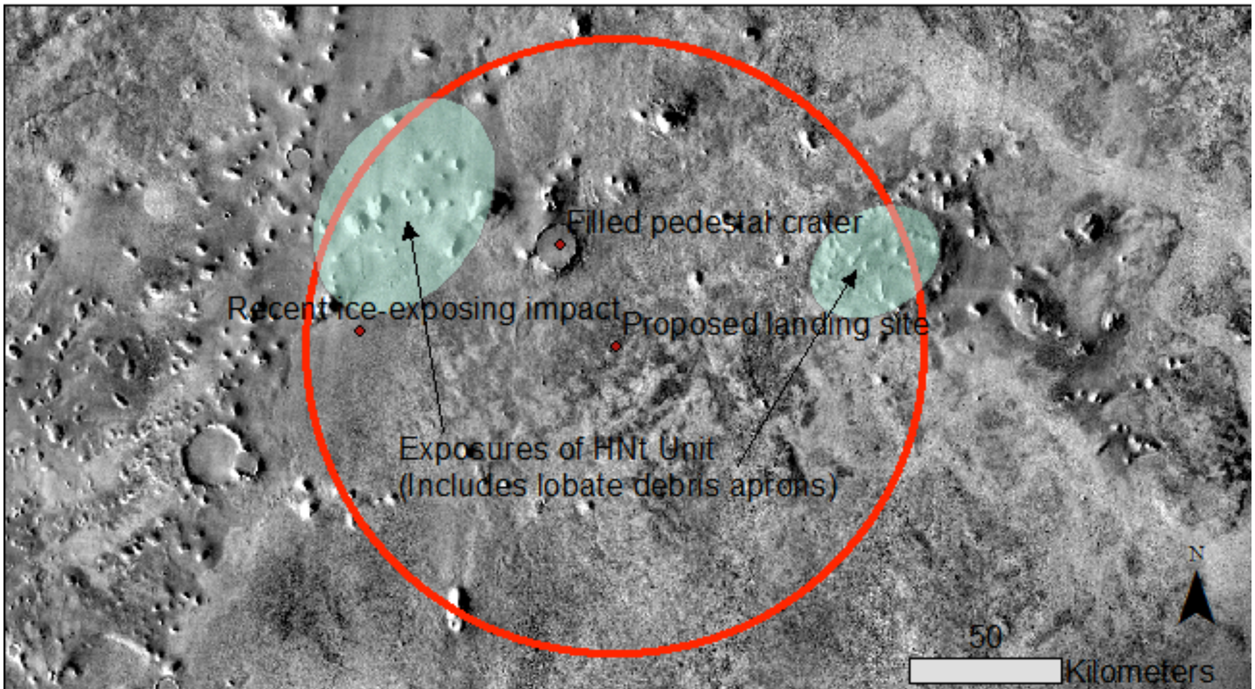

Figure 1: Erebus Montes EZ.

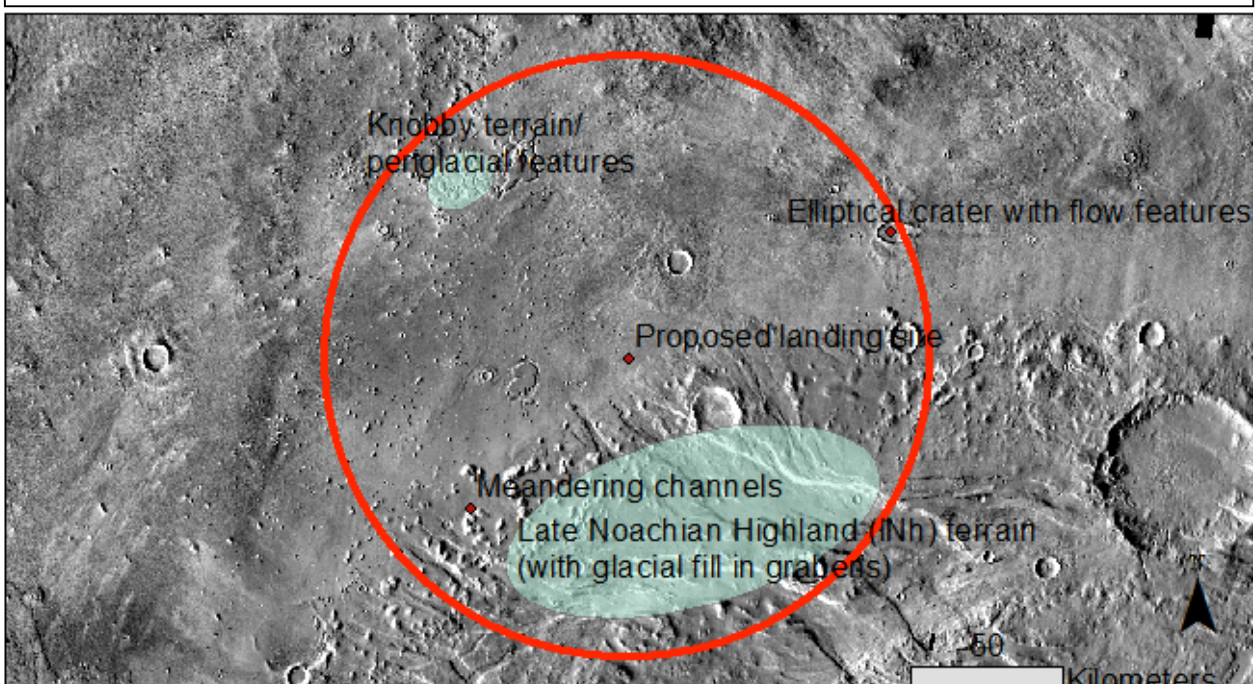

Figure 2: Acheron Fossae EZ.