Equatorial Opportunities for Humans on Mars

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Introduction. The goals of a human Mars mission are to establish a permanent presence in space and to study the evolution of the planet. Selection of an exploration zone suitable to both of these mission goals is therefore of paramount importance. The equatorial site presented here (-18.83°N, 310.79°E, Figure 1) fits the engineering and resource criteria while maximizing the science return of a human Mars mission.

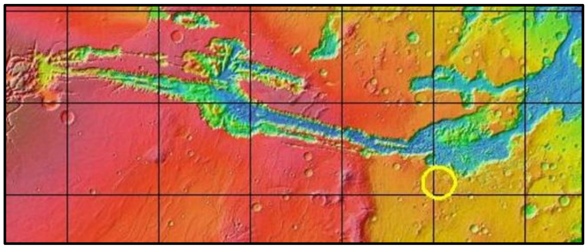

Figure 1. MOLA colorized elevation of Valles Marineris with exploration zone (yellow circle).

Scientific Relevance. Liquid water is both a prerequisite for Earth-like life and an in-situ resource. The proposed exploration zone (EZ) is in proximity to recurring slope lineae (RSL), which likely contain liquid water [1]. In addition, five sites containing hydrated minerals [2] and seven sites containing chlorides [3] – possible evaporative products – are contained in the EZ.

The major geologic processes that have dominated Mars' surface are represented in this EZ. Numerous impact craters are accessible by crew, including unique morphologies such as rampart craters which may have formed via impact into a water-rich substrate [4]. The formation of Valles Marineris – the largest canyon in the Solar System – is one of the biggest mysteries in Mars science; this EZ is ideal for studying the tectonics that formed it. Volcanic activity likely occurred in this region as indicated by morphologies resembling terrestrial maar volcanoes and the general abundance of basalt. In addition, a transition in Mars' remnant magnetic field lines is present in this EZ, potentially providing insights into the earliest part of Mars' geologic history [5]. Finally, the contact between two of the largest geologic units on Mars – the mid- and late-Noachian highlands – provides a window into the period during which water was actively shaping the martian surface [6].

Engineering Constraints and Resources. The landing and habitation sites are smooth (slopes <10°) at Mars Orbiting Laser Altimeter (MOLA, 100m) scales [7]. The region is also low in dust as measured by the Thermal Emission Spectrometer (TES) [8]. Early missions will be in proximity to a chloride site and multiple small, accessible impact craters, allowing substantial science operations without the need to travel long distances. Science and resource regions of interest (ROIs) were selected to allow for a gradual branching-out within the EZ. Thermal inertia measurements identify small regions within the EZ comprised of sand-sized particles, providing raw materials for construction. In addition to the water outlined in the previous section, ample resources are available for human use, making this site ideal for sustained surface operations.

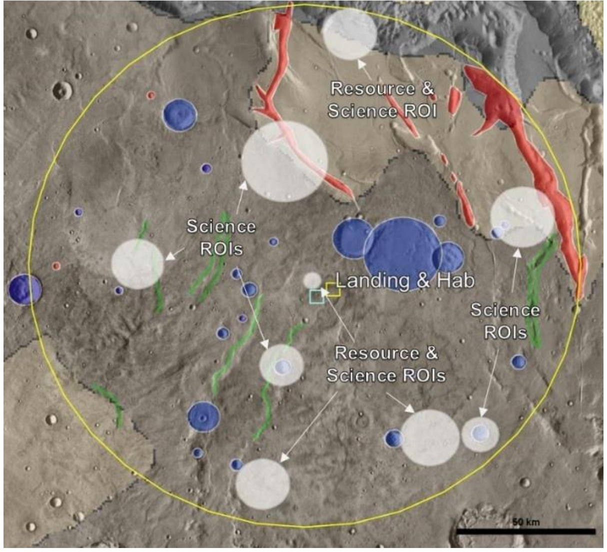

Figure 2. EZ (large circle) and Science/Resource ROIs (white circles). Major impact craters (blue), valleys (red), tectonic features (green). Landing/habitation sites at center (squares).

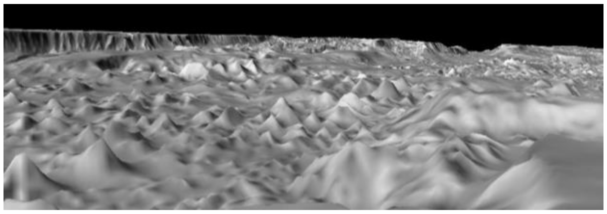

Figure 3. The view from south Valles Marineris, a source of excitement and engagement for the public (THEMIS Day IR on MOLA, 1.5x vert. exaggeration).

References: [1] McEwen, A., et al. (2014) *Nature Geoscience*, *Vol 7*. [2] Carter, J., et al. (2013) *JGR*, *118*. [3] Osterloo, M. et al. (2008) *Science*, *319*, 1651. [4] Head, J., and Roth, R. (1976) *The Lunar Science Institute Meeting*, *50*. [5] – Connerney, J. E. P., et al. (2005) *Proceedings of the Nat'l Academy of Sciences*, Vol. 112. [6] Tanaka, K., et al. (2014) USGS Map SIM 3292. [7] Zuber, M., et al. (1992), *JGR*, *97*. [8] Ruff, S. and Christensen, P. (2002) *JGR*, *107*.