SITE SELECTION FOR THE FIRST SUSTAINABLE MARS BASE.

D. C. Barker[1], G. James[2], G. Chamitoff[3] and S. Clifford[4], [1]MAXD, Inc. PO Box 58915 Houston TX, 77059, [2]NASA, JSC, [3]Texas A&M University and [4]LPI.

Introduction: We propose a landing site for establishing a sustainable and expandable Martian base, intended for permanent habitability, and based on the identification of an accessible local supply of water. Currently there are few data sets that can be used to accurately identify the presence and distribution of surface and near-subsurface water (e.g., the MARSIS and SHARAD orbital radar sounders on ESA's Mars Express and NASA's Mars Reconnasaince Orbiter and the Gamma Ray Spectrometer (GRS) on NASA's Mars Odyssey spacecraft).

Site selection based on resource utilization requires proven reserves (defined by mining industry standards as an amount of a resource estimated with reasonable certainty and deemed recoverable from well-established or known reservoirs and ultimately producible given known techniques). Given current data, few locations, especially ones containing multiple resources in close proximity, have yet to be identified on Mars.

Because our primary motivation is to establish a permanent human settlement on Mars, our landing site selection is constrained, not only by the collocation of local opportunities for scientific discovery, but more importantly by the availability and accessibility of extractable reservoirs (i.e., producible reserves) of water ice [1, 2]. Under our modified criteria, there are 3 general regions that satisfy our selection process – all of which lie within the northern plains (Fig. 1). Once the presence of adequate resource has been established, then these regions can be further assessed in terms of their scientific priority (e.g., as determined by the MEPAG Goals, Objectives and Investigations document).

We believe that a Landing Site (LS) located in Arcadia Planetia, along the Phlegra Dorsa, at 39°N 172°E, is the best candidate for the given constraints (Fig. 2 and 3). Besides a high water content (Fig.4), the site is located in an area of low dust content (Fig. 5), moderate thermal ineritas (Fig. 6), and low rock abundances (Fig. 7), well below the mean surface datum (to maximize atmospheric braking performance in support of entry, descent, and landing of heavy (>10 mt) vehicles, provide greater shielding against solar and cosmic radiation and serve as a resource reservoir (e,g., CO_2).

Resource ROI: As stated, this site was selected based on the need to access water. The GRS map inidicates a water content of >4 wt% throughout the exploration zone (EZ), while a MARSIS-derived surface permittivity of ~4 is consistent with either a porosity of ~35% or a volumetric ice content of ~60% for the top ~60-80 m of the near-subsurface [8]. The site is further situated in a area of moderate albedo and thermal inertia indicating fine grained materials, which are useful for ISRU processing and construction. Sheet silicates (Fig. 8) may be useful for engineering and manufacturing purposes.

Science ROI: While identifying a landing site with an accessible source of water is our primary selection criteria, our proposed site has an EZ that encompasses many points of high scientific interest. The geology (Fig. 9) in the EZ is confined within the Early Hesperian transition (eHt) unit [9]; yet, HiRise and CTX indicates many local and complex morphologies, including several ~10-15 km diameter fuidized ejecta craters (to the north and south of the LS) and numerous exposures of hydrated minerals (Fig. 10). Lastly, the large (~75 km diam.) crater Tyndall, lies tanailizingly just outside our 100 km EZ.

Discussion: In order to assure a sustainable presence on Mars, Mars exploration must be driven by programmatic goals that are themselves sustainable, and at a cost that is sufficient to ensure progress and maintain long-term public and political support [11]. Identifying landing sites based solely on science objectives, before reliable and sustainable resource acquisition will limit future missions and jeopardize exploration and permanent habitation of the planet.

Additional high-resolution measurements (by gamma-ray and neutron spectroscopy, ground penetrating radar, and mineralogically-sensitive mapping spectrometers) are needed to accurately identify the presence of surface and near-subsurface volatile and mineralogical resources. Ultimately, given the need to secure quantities of easily extractable water, landing sites at even higher latitudes within the northern plains (e.g., 49°N, 126°E; 49.5°N, 160°E; and 47°N, 13°W), will need to be considered.

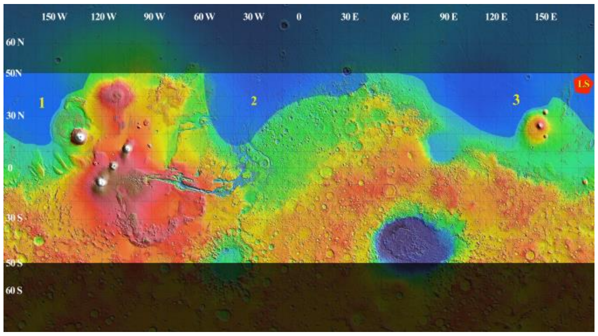

Fig 1 MOLA shaded relief showing three downselect-

ed priority regions and proposed landing site as indicated by the red LS marker in region 3.

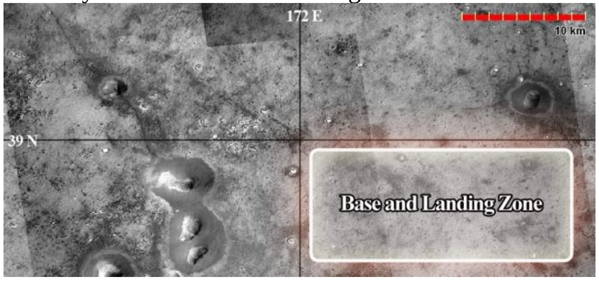

Fig. 2 CTX image showing base and landing zone.

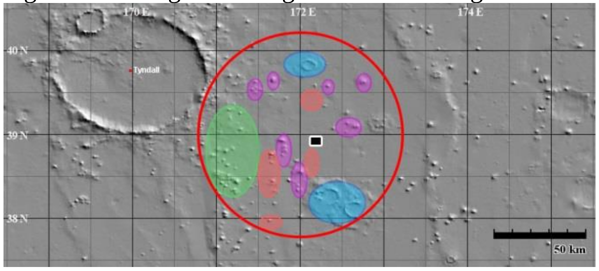

Fig. 3 MOLA shaded relief showing 100 km EZ; landing site in black; Science/Resource ROIs: blue-fluidized impact ejecta, green-hydradted minerals, purple-domes and red-sheet silicates.

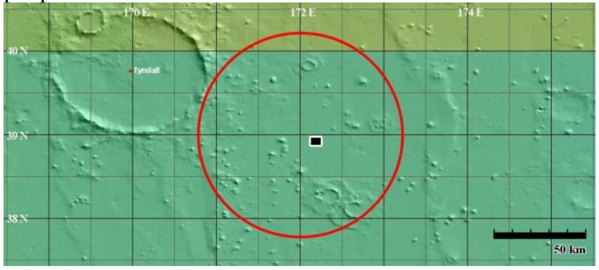

Fig. 4 GRS water content (> 4 wt% in green) map [3].

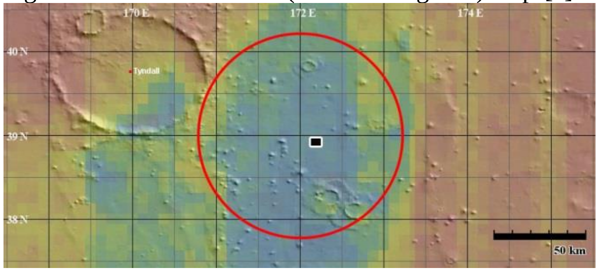

Fig. 5 OMEGA dust map [4].

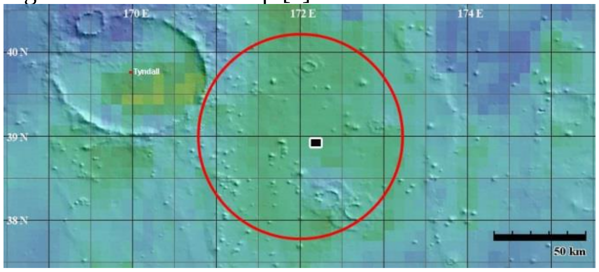

Fig. 6 TES thermal inertia map [5].

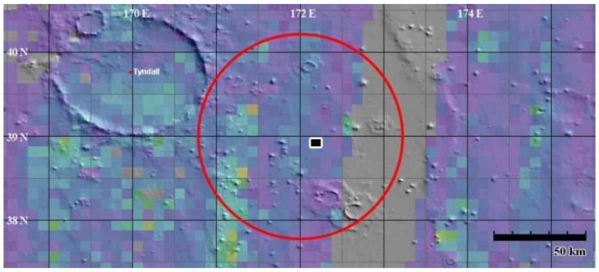

Fig. 7 TES global rock abundance map [6].

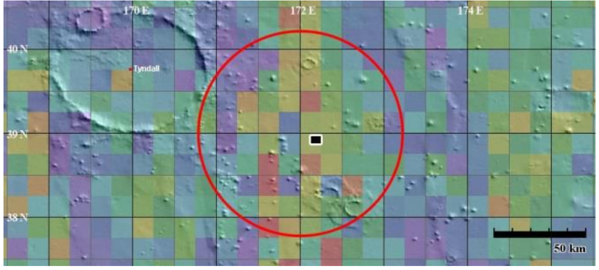

Fig 8 TES sheet silicates and glass map [7].

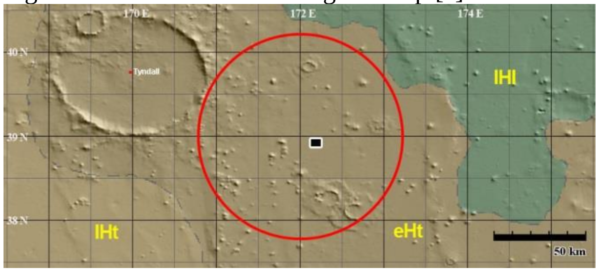

Fig 9 EZ geology within plains-forming deposits [9].

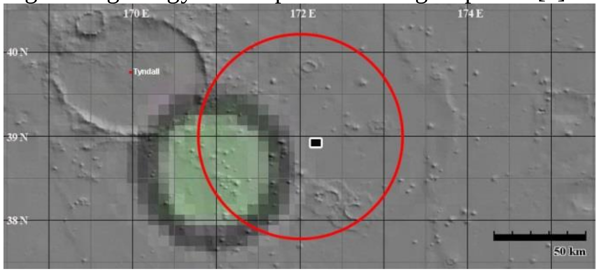

Fig 10 OMEGA/CRISM hydrated mineral map [10].

Additional Information: All landing region maps were created using J-Mars [12] and color map registrations are from low relative values (blue) to high values (red).

References: [1] Chamitoff, G., et. al. (1998) NASA/TM-98-206538. [2] Chamitoff, G., et. al. (2005) Acta Astronautica, 56. [3] Boynton, W. V., et. al. (2007) J. Geophys. Res., 112, E12S99. [4] Ody, A., et. al., (2012) J. Geophys. Res. Planets, 118. [5] Christensen, P. R., and H. J. Moore (1992), The martian surface layer, in Mars, pp. 686-729, University of Arizona Press, Tucson, AZ. [6] Nowicki, S. A., and P. R. Christensen (2007) J. Geophys. Res., 112, E05007. [7] Bandfield, J. L., (2002) J. Geophys. Res., 107. [8] Mouginot et al., (2012) Geo. Res. Let., 39, L02202. [9] Tanaka et. al., (2014) USGS Mars Map 3292. [10] Carter, J., et. al.,. (2013) J. Geophys. Res. Planets, 118. [11] Barker, D. C., (2015) Acta Astronautica, 107. [12] Christensen, P. R. et.al. (2009) JMARS–A Planetary GIS, AGU, IN22A-06.