A Resource-rich, Scientifically Compelling Exploration Zone for Human Missions at Deuteronilus Mensae, Mars

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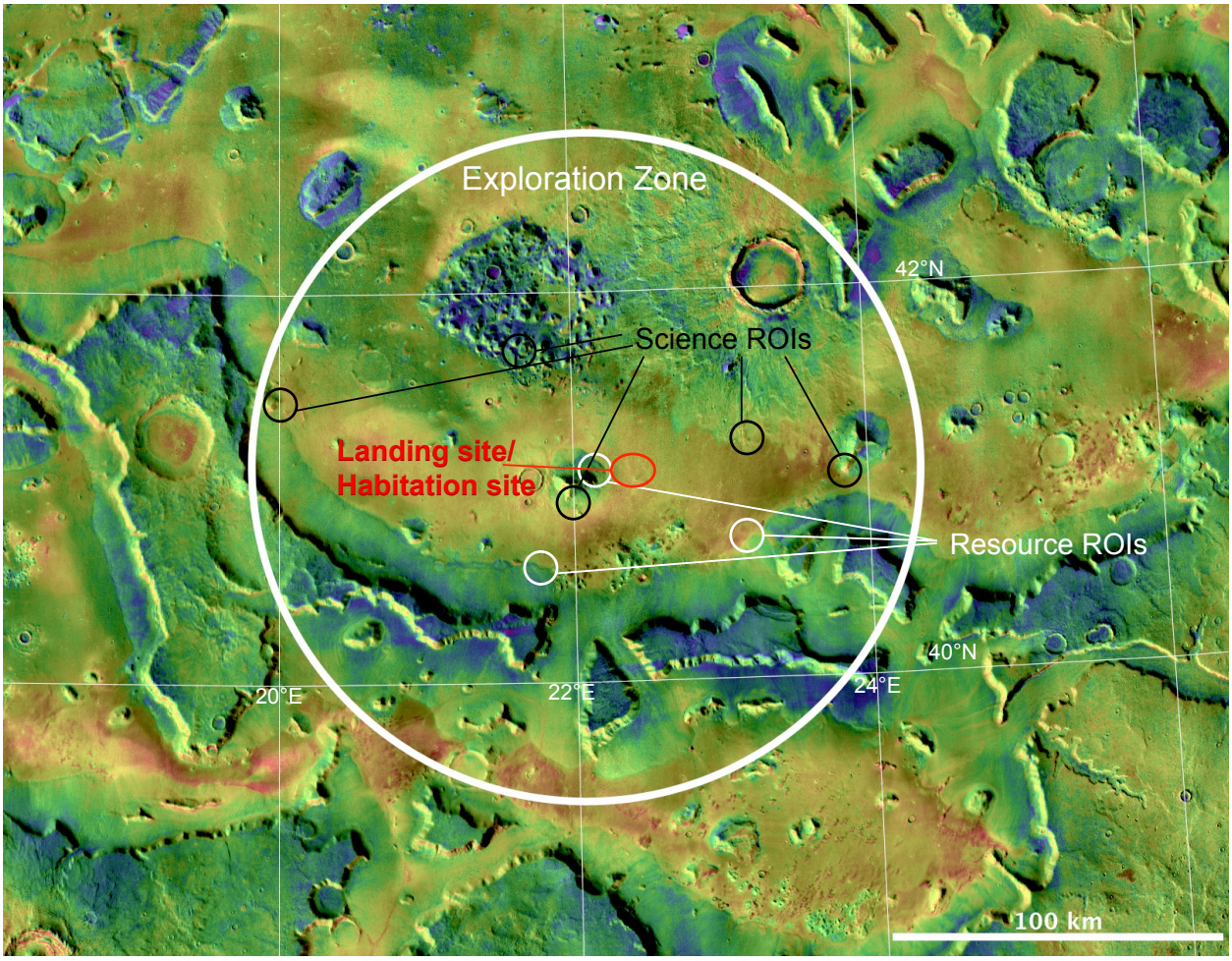
The Deuteronilus Mensae region of Mars is promising as a potential landing site for human exploration because it contains vast, readily accessible deposits of water ice in a setting of key scientific importance. The proposed Exploration Zone (EZ) is centered on a landing site adjacent to a small massif that is partially surrounded by a "lobate debris apron" deposit shown by orbital radar sounding to consist primarily of nearly pure water ice hundreds of meters thick [1].



Deuteronilus Mensae Exploration Zone on THEMIS infrared day time image colored by THEMIS night time temperature (red is warm, blue is cold). Resource regions of interest (ROIs) include a small ice-rich apron adjacent to the landing site, and several others at greater distances. Science ROIs include remnant Noachian highlands massifs, sequences of likely ice-rich deposits associated with a remnant impact central peak in Hesperian terrain, the edge of a multiple-lobed ejecta crater, and the lobate aprons themselves, interpreted to be remnant glaciers of Amazonian age.

The proposed EZ meets the provided engineering constraints: latitude 39-43 deg. N, longitude 20-24 deg. E; elevation -2 to -4 km wrt Mars mean planetary radius; moderate thermal inertia; relief < 100 m and slopes < 15 deg. along possible traverses; rock abundance to be investigated (no large boulders observed in HiRISE; thermal inertia consistent with low rock abundance).

Access to water ice for ISRU purposes requires removal of overburden, estimated to be between 0.5 and 10 m thick [1]. While the high end of this range is potentially challenging to remove, once the ice is exposed its expected purity and thickness mitigate processing complexity. Terrain between the landing site and the primary resource ROI appears flat and smooth in available data.

Science ROIs in the EZ contain materials from all three major martian geologic periods. Remnant glacial ice from the Amazonian can be sampled for geochemical indicators of climate conditions and for bio-signatures. Micro-environments associated with the remnant ice likely experienced periodic melting temperatures, providing targets for the search for extant or recent life. The landing site and much of the EZ sits on Hesperian age plains terrain, which while of uncertain origin, contains numerous indicators of periglacial processes. North of the landing site is a chaotic terrain that is interpreted to be a remnant of the central peak of a large impact crater. This terrain contains numerous exposures of collapsed layered terrain that likely contain a record of the environmental/climatic conditions of the Hesperian. The regional setting of the dichotomy boundary allows access to Science ROIs at remnant massifs and scarps of Noachian age highlands terrain. These outcrops contain a record not only of the origin of the Noachian lithology but also of the processes that created the dichotomy itself. Several of the Science ROIs contain contacts among 2 or 3 units of diverse ages and will provide insight into erosional and depositional histories. A moderately fresh impact with a large (50 km radius) multiple lobed ejecta blanket occupies the northeast sector of the EZ. This will provide a rare opportunity observe such a deposit in situ, to understand the dynamics of its formation and the role of volatiles.

Reference:

[1] Plaut, J.J., A. Safaeinili, J.W. Holt, R.J. Phillips, J.W. Head, R. Seu, N.E. Putzig, A. Frigeri, 2008a, Radar evidence for ice in lobate debris aprons in the mid-northern latitudes of Mars, Geophys. Res. Lett., doi:10.1029/ 2008GL036379.