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PROPOSED MARS SURVEYOR LANDING SITES IN NORTHERN MERIDIANI SINUS, SOUTHERN ELYSIUM PLANITIA, AND ARGYRE PLANITIA. T. J. Parker[1] and K. S. Edgett[2], [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena CA 91109, tparker@jpl.nasa.gov; [2]Deparment of Geology, Arizona State University, Tempe, AZ 85287.

Introduction

Our objective is to propose two landing sites that the Mars Surveyor 2001 Lander and Athena rover could go to on Mars that would meet the safety requirements of the spacecraft landing system and optimize surface operations (chiefly driven by power and communications requirements). An additional site within Argyre Planitia, initially proposed by Parker to the Mars Surveyor Landing Site program, is also proposed for potential consideration for post-2001 missions to Mars, as it is well outside the current latitude limits for the Athena rover. All three sites are designed to be situated as close to a diversity of geologic units within a few kilometers of the landing site so that diversity can be placed in a geologic context. This objective is very different from the Mars Pathfinder requirement to land at a site with a maximum chance for containing a diversity of rocks within a few tens of meters of the lander. That requirements was driven by the Sojourner mobility limit of a few tens of meters. It can be argued that the Athena project, with its much larger mobility capability, might actually want to avoid such a site, because placing collected samples in geologic context would be difficult. While it has been argued, both before and after the Mars Pathfinder landing, that the provenance for local blocks may be determined by orbiter spectra, primarily from the MGS TES instrument, our ability to do so has yet to be demonstrated. Indeed, several months after conclusion of the Pathfinder mission, we have yet to reach a consensus on the composition of local materials.

Our primary data set for selecting a landing site within the latitude and elevation constraints for the 2001 mission is the Viking Orbiter image archive. The site must be selected to place the landing ellipse so as to avoid obvious hazards, such as steep slopes, large or numerous craters, or abundant large knobs. For this purpose, we chose a resolution limit of better than 50 m/pixel. This necessarily excludes from the present study images from current and future orbiter spacecraft, until such data does become readily available. Within each proposed region, it may be possible to identify additional sites once these data become available.

Second, the fine-component thermal inertia data [1], compiled by P. Christensen and made available to the Mars Pathfinder project, should be greater than about 5 or 6 cgs units (10^{-3} cal cm^{-2} $s^{-0.5}$ K^{-1}). Low thermal inertias imply dusty environments, which could pose a mobility hazard. Similarly, the albedo ([2] digital file made available to the Mars Pathfinder project by P. Christensen) of the site should not be particularly high, which would also suggest dusty surfaces. Low albedos are preferred, as they often coincide with low Viking red:violet ratios and indicate less dusty surfaces. Next, the Modeled Block Abundance [1] should also not bee too high or too low. Based on the Viking Lander and Mars Pathfinder experiences, percentages of blocks should be on the order of 5–22%. Too many blocks could pose a hazard to the landing and mobility. Too few blocks could also indicate a dusty surface.

Primary Landing Site: Northern Meridiani Sinus (Proposed by T. J. Parker and K. S. Edgett)
Vital Statistics:
*Latitude, Longitude: 0–3°N, 350–2°W.
*Elevation (Viking): ~0.5–1.5 km.
*Viking Orbiter Image coverage: Excellent coverage by 15–25 m/pixel images (orbits 709A and 410B). Possible stereo coverage in region where two orbits overlap (probably small parallax angle, as these orbits are not listed in NASA Contractor Report 3501)
*Albedo: ~0.18–0.26
*Block Abundance: 5–26%
*Fine-Component Thermal Inertia: 5–9 cgs units

This region consists of bright deposits similar to those described by Edgett et al. [3], that also lie within a prominent dark albedo region. These deposits are flat-lying, to such a degree that they ramp against topography rather than draping over it. This led Edgett and Parker [4] to suggest that they may be subaqueous sediments, possibly lacustrine or marine evaporates, laid down sometime from the late Noachian to middle Hesperian (age determination pending crater counts). A contact between this material and elevated, dissected highlands to the south was identified [4], and this is described by Edgett et al. [3].

Our desire in proposing this landing site is to sample the edge of this deposit where it has been exposed through etching, presumably Eolian deflation (the deposit, though in the highlands, is itself only moderately cratered). This should enable access to *in situ* stratigraphy. The actual landing site will be selected where slopes are not expected to be steep, such that the rover itself should be able to traverse them and sample layered materials on the way, either up or down the slope. Perhaps due to uncertainties at this time as to the friability or meter-scale roughness of the deposit, it might make sense to place the landing ellipse on the exhumed highland surface adjacent to the deposit rather than landing on it and driving downslope. This should also enable imaging the margin for evidence of layering should it prove too difficult to climb. A target ellipse on the highland surface should also allow Athena access to ancient Noachian highland materials, particularly if placed near crater ejecta or an inlier of knobby material.

Secondary Landing Site: Southern Elysium Planitia (Proposed by T. J. Parker)
Vital Statistics:
*Latitude, Longitude: 1.5–3.5°S, 195–198°W.
*Elevation (Viking): –1.0 km.
*Viking Orbiter Image coverage: Excellent coverage by 15–25 m/pixel images (orbit 725). Possible stereo coverage between images from beginning and end of

orbit that overlap (probably small parallax angle, as these orbits are not listed in [5])
*Albedo: ~0.27–0.28
*Block Abundance: 4–7%
*Fine-Component Thermal Inertia: ~3 cgs units

This region consists of eroded knobby material, probably of Noachian age, though much of the crater population has been destroyed, that is onlapped at a sharp contact by an extensive plains unit in southern Elysium Planitia that is Amazonian in age. The plains materials have been attributed to unusually low-viscosity flood lavas [6] from fissures south of the Elysium volcanic rise, or to lacustrine material associated with a large, Amazonian lake at the source of Marte Vallis [7]. Parker and Schenk [8] presented evidence in support of the latter interpretation, though they attributed the putative shore morphology to an embayment of a northern plains ocean into the southern Elysium region. Detailed examination of the margin of the deposit, showing erosion, not simply burial, of small crater rims and fluidized ejecta blankets, also points to lacustrine or marine sedimentation rather than volcanic plains burial.

The plains surface exhibits a “crusty” appearance that many researchers have attributed to pressure ridges in lava flows. In a lacustrine context, they also resemble pressure ridges in desiccated evaporite deposits and salt-rimmed pools (now dry) similar in scale and morphology to spectacular, hundred meter-scale pool rims in alkaline Lake Natron, East African Rift.

The eroded highland margin surface adjacent to these plains appears to be fairly smooth, even at 15 m/pixel. Isolated knob inliers are scattered from a few kilometers to several tens of kilometers apart. Heights of the knobs have not been measured yet but, based on experience with similar features in the Pathfinder landing ellipse, are probably typically on the order of several tens of meters high and smaller, though some of the largest knobs in the region are probably up to a few hundred meters high. Two craters larger than a kilometer in diameter, with fluidized ejecta deposits, lie nearby the proposed landing site.

Very high-resolution images from MOC should help to determine whether a landing site navigable by the Athena rover could be placed in this region. The space between knobs and craters is large enough to enable placement of a target landing ellipse between them but still provide access to one or more of them and to the margin of the Elysium plains material.

Post-2001 Mars Surveyor Landing Site: Argyre Planitia (Proposed by T. J. Parker)

Vital Statistics:
*Latitude, Longitude: 55–56°S, 41–43°W.
*Elevation (Viking): 1.0 km.
*Viking Orbiter Image coverage: Excellent coverage by 40 m/pixel images (orbits 567B, 568B, 569B). Excellent stereo coverage with large parallax angles over the entire landing site region, and much of central and southern Argyre.
*Albedo: ~0.23–0.24
*Block Abundance: No data
*Fine-Component Thermal Inertia: No data

The floors of both the Argyre and Hellas basins contain etched layered materials that are probably thick accumulations of channel or lacustrine sediments [9, 10]. The deposits in Hellas are much more eroded than those in Argyre, and Hellas lacks a channel outlet. Argyre is unique in that Uzboi Vallis flowed out of the basin, requiring overflow of a standing body of water within Argyre [11]. This makes it the largest impact basin on Mars with channels both draining into it and flowing out from it. Hellas’ channels may be catastrophic flood channels, whereas Argyre was fed by modest-scale valley networks, though the outlet at Uzboi Vallis was a catastrophic flood.

Highland craters and basins of this kind should be high-priority landing targets for missions intended to focus on the search for either prebiotic organic materials or even simple fossil microorganisms. Basins with internally-draining valley networks should be preferred over flood channels, as they could have provided the long-term influx of water favorable to the origin of life. (Catastrophic floods are not conducive to fossil preservation, due to their very short durations and high transportation energies). They also afford an opportunity to study the evolution of the planet’s climate and volatiles during the period of time between the late Noachian and early Hesperian, when a drastic change from a proposed early warm, wet climate to one more closely resembling the modern environment is thought to have occurred. Large basins of this type are better targets than smaller ones, because the local environment would be less susceptible to freezing or drying caused by large swings in climate.

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