PHOENIX LANDING SITE SELECTION UPDATE. P. H. Smith[1], L. K. Tamppari[2], R. E. Arvidson[3], W. V. Boynton[1], and the Phoenix Science Team. [1]University of Arizona, 1415 N. Sixth Ave, Tucson, AZ 85705, (psmith@lpl.arizona.edu), [2]Jet Propulsion Laboratory, 4300 Oak Grove Dr., M/S 264-623, Pasadena, CA 91109, [3]Washington University, Campus Box 1169, 1 Brookings Drive, St. Louis, MO, 63130-4862.

Introduction: The Phoenix Mars mission, to be launched in August 2007, has two primary objectives: to study the history and current state of water in the northern polar environment and to understand if the near surface ice is hospitable for life. To accomplish these objectives, the Phoenix mission will land at a polar site (65-72° N) in late-May 2008 and operate for at least 3 months.

A special session was held at LPS XXVII in 2006 [1,2] to present the landing site constraints and open a discussion between interested members of the community and the project. The discussion was useful and well attended (some scientists were not able to find space in the room). In this abstract we present progress on site selection during the last year.

The Landing Site Selection Process: Selecting a landing site that will provide the right kinds of samples as well as one that is safe for the lander spacecraft has been the focus of the Landing Site Working Group chaired by R. E. Arvidson. This group is responsible for the data acquisition and analyses required to evaluate the potential landing regions for both safety and scientific merit.

The verification that the selected site gives a high probability of a safe landing comes from the activities of the Entry-Descent-Landing group, jointly staffed by JPL and Lockheed Martin personnel. A three dimensional model of the landing surface becomes part of the Monte Carlo modeling of the entire landing process. After thousands of runs randomly varying all the environmental variables, the percentage of safe landings can be calculated. While this can be comforting, other factors like equipment failures or software anomalies need to be evaluated separately to give the complete picture.

The criteria used to determine an acceptable landing site are as follows: (1) the surface elevation must be < -3.5 km with respect to the MOLA aeroid, (2) there must be a high probability of water-ice accessible within the top 1-m of the surface, (3) the landing site must be within the latitude range 65-72 N based on power and communications constraints, (4) there must be geo-morphological evidence of subsurface ice, (5) the slopes must be < 16°, (6) the rock abundance must be < 18%, (7) the winds < 20 m/s, and (8) hazardous craters and their ejecta must be avoided.

Four regions (7° lat x 20° long) have been identified as worthy of further study and remote sensing observations obtained. By February 2007, a single region will be chosen and three sites selected within it for intense evaluation. After the Mars summer observing season is over and the data analyzed, a single site will be identified and certified through a thorough review process. This will be completed by June 2007.

Finding the Ideal Location: The team defined 4 landing regions for intensive study in December 2003 (see Fig. 1). The LSWG then began efforts to characterize each region for scientific merit and distinguishing factors as well as safety concerns. The initial focus was on the differences in ice amount and depth to ice among the candidate regions using the Odyssey GRS dataset [4]. Comparisons were drawn with theoretical estimates of the depth of the dry soil overburden as well as additional observational techniques [5]. The soil cover thickness over ice is a primary driver since the history of the ice is written into the soil chemistry and mineralogy by action of the ice melt on the soil. Our current best estimates for the depth to the hard icy layer are 2-16 cm.

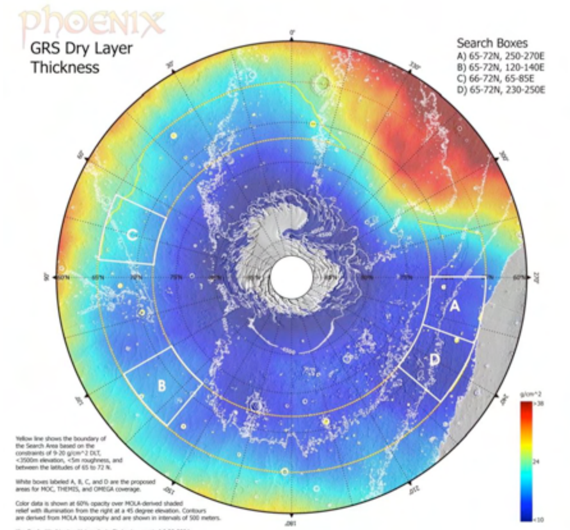

Figure 1. North polar view of Mars from Odyssey's GRS instrument showing the 4 Phoenix landing site regions A-D. Blue represents a soil depth to ice of 10 g/sq-cm at regions A and D and C is 20 g/sq-cm—B is intermediate.

By August 2006, the slope, rock abundance, and boulder characteristics had been determined [6-9] using MOLA and MOC data. Further insight into the rock abundance was attempted with bi-static radar experiments [10, 11] and analysis of Earth-based radar data. The geomorphology in each region was examined with MOC, THEMIS and Mars Express HRSC data [12, 13]. Finally, Mars Express OMEGA data were brought to bear on the characterization effort [14].

The 4 regions were narrowed to B last summer. Three sites containing landing ellipses were chosen for further study contingent on new observations from MRO and the risk of a boulder-strewn surface.

As fate would have it, the first images from HiRISE in October showed areas in B with extremely high rock counts associated with partially buried craters and the centers of large polygons. Since then our procedures have changed to an all out search for a safe haven.

HiRISE images have provided rock counts accurate to about 1.5 m diameter [15], underestimating smaller rock densities. Local abundances have been compared with THEMIS predawn thermal IR maps that cover our entire latitude girdle although with some gaps. Expecting a close correlation between rocky areas and hot spots in the THEMIS IR data, we have targeted the cooler areas of the map for HiRISE images.

As of late December, 2006, we have identified three new boxes in regions A and D that are both cold in the Themis IR and have low rock densities based on the rock counts that we have performed. Work is progressing rapidly to map out three 1-sigma landing ellipse in HiRISE images and to bring to bear all relevant remote sensing data sets to understand the suitability of the sites.

Even after launch there are opportunities during the first 2 trajectory course maneuvers TCM to adjust the landing site. A large change can be made at TCM#1 without much penalty in fuel usage with smaller adjustments possible as we approach the planet.

Another opportunity to image the landing site comes a few months before landing as the seasonal ice cap recedes. These observations will be useful to motivate small tweaks to the landing ellipse position.

Conclusions: Phoenix site selection has been a challenging activity because of the unexpected rock abundances. Use of extensive HiRISE and THEMIS data have allowed us to move from the original area (Region B) to three boxes within Regions A and D that have much lower rock abundances than found in B. This rapid discovery and response to hazards is a consequence of having a program of Mars exploration with cooperative efforts among the missions that comprise the program. .

Acknowledgments: Finding a safe landing site has been a group effort involving many individuals and crossing over project boundaries. There has been an attitude of camaraderie and good spirit amongst the group that makes this search for the perfect polygon a good experience. I particularly want to thank A. McEwen for providing us with HiRISE images and P. Christensen for his help with THEMIS data sets. G. Lee's review board has encouraged us to consider all the risks and maintain the mission goals.

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