WHERE AND HOW TO ACQUIRE SAMPLES FOR THE PHOENIX MISSION. L. K. Tamppari[1], R. E. Arvidson[2], P. H. Smith[3], J. Guinn[1], R. Bonitz[1], and the Phoenix Science Team. [1]Jet Propulsion Laboratory/Caltech, leslie.tamppari@jpl.nasa.gov, 4300 Oak Grove Dr., M/S 264-623, Pasadena, CA 91109, [2]Washington University, St. Louis, MO 63130, [3]University of Arizona, Tucson, AZ 85721.

Introduction:

The Phoenix Mars Scout mission, to be launched in August 2007, has two high level objectives: to study the history and current state of water in the northern polar environment and to understand if the high latitude landing site is a place that would be hospitable for life in the current or past epochs. To accomplish these objectives, the location of the landing site as well as the ability to acquire and deliver samples to deck-mounted instruments are high priorities.

Picking a landing site:

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 Phoenix Team Landing Site Working Group. This group is responsible for the data acquisition and analyses required to understand the potential Phoenix landing regions for both safety and scientific merit.

In the Phoenix proposal (2003), a possible landing site (near 240 E, 70 N) was proposed. This was an ideal location to accomplish the Phoenix science objectives as it had been recently shown to have a substantial amount of H, presumably in the form of frozen water, in the top 1-meter of the surface [1]. After selection, the Phoenix team began searching for the best landing location, considering certain requirements, namely, (1) the surface elevation must be <-3.5 km with respect to the MOLA geoid, (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 navigation and communications constraints, (4) there must be geomophological evidence of subsurface ice, (5) the slopes must be < 15°, (6) the rock abundance must be < 18%, and (7) hazardous craters must be avoided. This led the team to define 4 landing regions in December 2003 (see Fig. 1). Soon thereafter, region D (containing the original proposal site) was deselected because of its similarity to region A and the fact that it had many more large, hazardous craters than region A.

The landing site working group then began efforts to characterize regions A, B, and C for scientific merit and distinguishing factors as well as safety concerns. The initial focus and was on the differences in ice amount and depth to ice among the candidate regions using the Odyssey GRS dataset [2]. This task was then supplemented with theoretical efforts to determine the depth of the dry soil overburden as well as additional observational techniques [e.g., 3]. This soil cover thickness over ice is a primary driver since we would greatly like to have soil to acquire and deliver to the on-board laboratory instruments as well as be able to dig through the dry soil layer to sample the underlying ice. We neither want too much soil nor too little. Our current best estimates for the depth to the hard icy layer are a few to about 16 cm maximum.

The slope, rock abundance, and boulder characteristics have also been determined [4-7] using MOLA and MOC data. Further insight into the rock abundance has been attempted with bi-static radar experiments [8-9] and analysis of Earth-based radar data. The geomorphology in each region has been examined with MOC, Themis and Mars Express HRSC data [10-11]. Finally, Mars Express OMEGA data have also been brought to bear on the characterization effort [12].

Given the analysis performed, the Phoenix team downselected to region B as of December 2005. Region B was chosen due to the following primary characteristics:

(1) The typical elevation is < -4 km with respect to the MOLA geoid, which yields additional margin for the lander system, and
(2) Of the 3 regions, region B has the "right" amount of dry soil overburden; region A was thought to be too little and region C may have the same or may have more.

Other characteristics were similar between all regions.

Once region B was selected, the team focused on defining the potential landing "boxes" and assessing those in more detail. These are centered on 70.5N/136E, 67.5N/130E, and 66N/136E. Typically, a landing ellipse is defined, which indicates the 99% probability zone for landing the spacecraft. The center of the ellipse is the highest probability landing location, and the size of the ellipse is determined by the precision of the spacecraft entry point into the atmosphere as well as the atmosphere that the spacecraft encounters as it flies in to land. The orientation of the landing ellipse is determined by the launch date and therefore is not known at this time. As a result, "boxes" encompassing the total possible landing ellipse orientations is defined.

Three landing boxes are defined at lower, middle, and higher latitudes. The lower latitude box may have more dry soil overburden and the higher latitude box will have better communications to the orbiting satellites. Currently, MOC images are being taken in these landing boxes. Starting in the fall 2006, the Mars Reconnaissance Orbiter will start taking Hi-RISE (high resolution camera) images of our landing boxes and other similar terrain. This will enable us to select the best box, again on a safety and scientific basis. This selection will be made no later than July 2007, one month before launch.

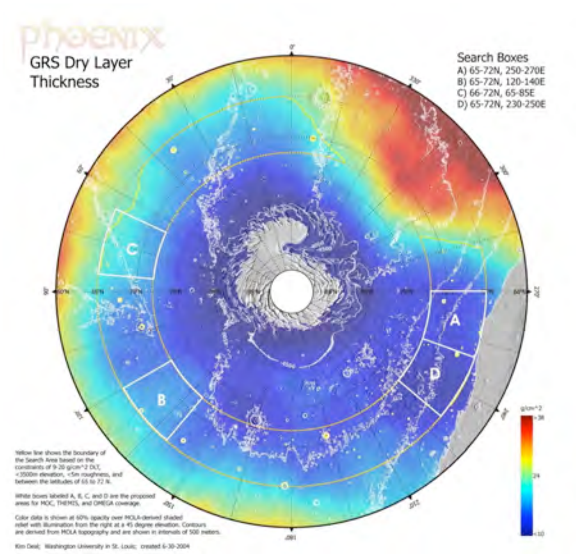

Figure 1. North polar view of Mars showing the original 4 Phoenix landing regions A, B, C, and D.

Soil acquisition tools:

Once the Phoenix lander has touched down on the surface of Mars (May 25 – June 5, 2008), our job will be to examine the soil and ice to determine the water content and history as well as the chemistry and mineralogy to understand if the landing site is a place that would be conducive to life. Our tool for acquiring and delivering these precious samples is the Robotic Arm (RA). The RA will be able to reach a wide area on the north side of the lander; the lander has azimuthal control during descent allowing it to land with the arm facing the north side. It is long enough that it can dig down to 1-m depth in dry, loose material. This is more than sufficient capability to access the dry soil down to the icy layer at the depth we expect - a few 10's cm at most.

The RA will acquire dry, loose soil by using the scoop mounted on the end of the arm. It has a capacity of ~300 cc and only a few cc's are needed for delivery into the laboratory instruments. Mounted on the underside of the scoop is a secondary blade to help ensure efficient sampling. This tool will help scrape up harder soils and will help break down clods that may be too big to deliver to the instruments. In addition to those, the RA also has a rasp mounted in the back of the scoop. This is a spinning tool that will grind very hard materials such as ice. In fact, it is similar to tools that are used to create ice sculptures. The ground material produced by this tool is deposited into the back of the scoop directly and then will be delivered to the laboratory instruments. This design was essential to reduce the total time between acquisition and delivery to prevent sublimation of the ice.

Conclusions:

The landing site characteristics and RA capabilities and uses will be more fully described in the oral presentation.

References: [1] I. G. Mitrofanov et al., *Science* **300**, 2003. [2] W. V. Boynton et al., 37th LPSC, 2006. [3] T. N. Titus et al., 37th LPSC, 2006. [4] J. J. Marlow et al., 37th LPSC, 2006. [5] R. Beyer et al., 37th LPSC, 2006. [6] R. L. Kirk et al., 37th LPSC, 2006. [7] B. S. McGrane et al., 37th LPSC, 2006. [8] H. M. Gunnarsdottir et al., 37th LPSC, 2006. [9] R. A. Simpson et al., 37th LPSC, 2006. [10] K. D. Seelos et al., 37th LPSC, 2006. [11] L. M. Barge et al., 37th LPSC, 2006. [12] F. Poulet et al., 37th LPSC, 2006.