Multi-Spectral Imaging of the Phoenix Landing Site: Characteristics of Surface and Subsurface Ice, Rocks, and Soils. D. L. Blaney[1], D. Archer[2], R. Arvidson[3], S. Cull[3], M. Ellehoj[4], D. Fisher[5], M. Hecht[1], M. Lemmon[6], M. Mellon[7], R. Morris[8], T. Pike[9], P. Smith[2], C. Stoker[10], and the Phoenix Science Team.[1]NASA Jet Propulsion Laboratory/California Institute of Technology, 4800 Oak Grove Drive, MS 264-422, Pasadena CA 91109 Diana.L.Blaney@jpl.nasa.gov, [2]University of Arizona, [3]Washington University St. Louis , [4]Niels Bohr Institute, [5]Geologic Survey of Canada , [6]Texas A&M , [7]University of Colorado, [8]NASA Johnson Space Center, [9]Imperial College London, [10]NASA AMES Research Center

Introduction: The Surface Stereo Imager (SSI) on Phoenix Lander lander collected images for 151 Martian days (Sols) including over 100 multi-spectral observations. [1]. Multi-spectral observations were targeted to collect compositional information of landing site materials and monitor change using 15 filters selected for geologic analysis (Table 1).

Table 1. SSI Geologic Filters.

Filter	Wavelength	Filter	Wavelength
L1	673 nm	R1	673 nm
L2	447 nm	R2	447 nm
L6	833 nm	R8	754 nm
L7	802 nm	RA	640 nm
L8	864 nm	RB	532 nm
L9	900 nm	RC	485 nm
LA	969 nm		
LB	1002 nm		

Surface Materials: Soils at the Phoenix landing site are generally consistent with soils measured at other locations on Mars and are rich in nano-phase iron oxides [2]. Rocks at the landing site showed a range albedos and textures. Low albedo rocks are consistent with materials of basaltic origin. Higher albedo rocks have spectral properties similar to the soils, with slightly higher albedos perhaps indicating that coatings are being formed on rock surfaces by the interaction of thin water films and the soils/dust at the landing site. Representative spectra are shown in Figure 1.

Subsurface Materials: The Phoenix Robotic Arm excavated much of the workspace and delivered samples to the MECA and TEGA instruments [3]. Surface and subsurface soils were spectrally similar. However, textural differences do exist related to cohesiveness [3,4]. No distinctive spectral signature was associated with the clods. Evidence for layering in the trenches and the dump piles was not detected, indicating that any soil stratification was not extensive enough to produce strong spectral differences. No optical evidence for high albedo salt layers (such as those associated with percholorates) was observed a the site.

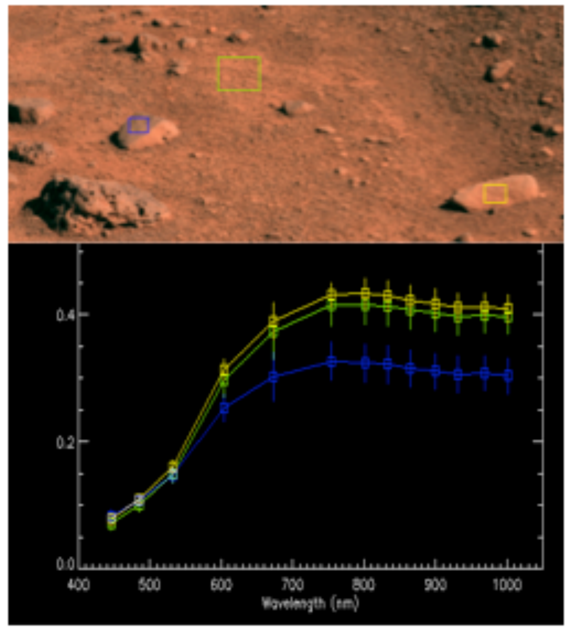

Figure 1. Example soil and rock spectra. Data from Sol 80 "Happy Panorama" Token 165C0. Color image produced using RA, RB, RC filters.

Two types of icy materials were exposed during excavation and monitored during the mission to understand their evolution. Further excavation was conducted to map the extent of these deposits. Depth to ice varied from ~1.6 cm to > 16 cm [5].

Type I Ice (Dodo-Goldilocks-Upper Cupboard): Excavations in Humpty Dumpty (Dodo-Goldilocks and Upper Cupboard trenches) revealed a high albedo deposit consistent with a relatively pure ice spectrally.

Dodo-Goldilocks was first exposed on Sol 9 with digging stopping on Sol 21. During the initial excavation, clods of ice/soil mixtures were produced that sublimated away over within 4 sols. Clod residue was minimal and spectrally consistent with very small amounts of soil in an ice mixture. The ice in Dodo-Goldilocks was then left undisturbed till Sol 99 and the sublimation process was monitored. Over time the ice signature decreased in the deposit and became consistent with the surface soil spectra seen at the landing site (Figure 2).

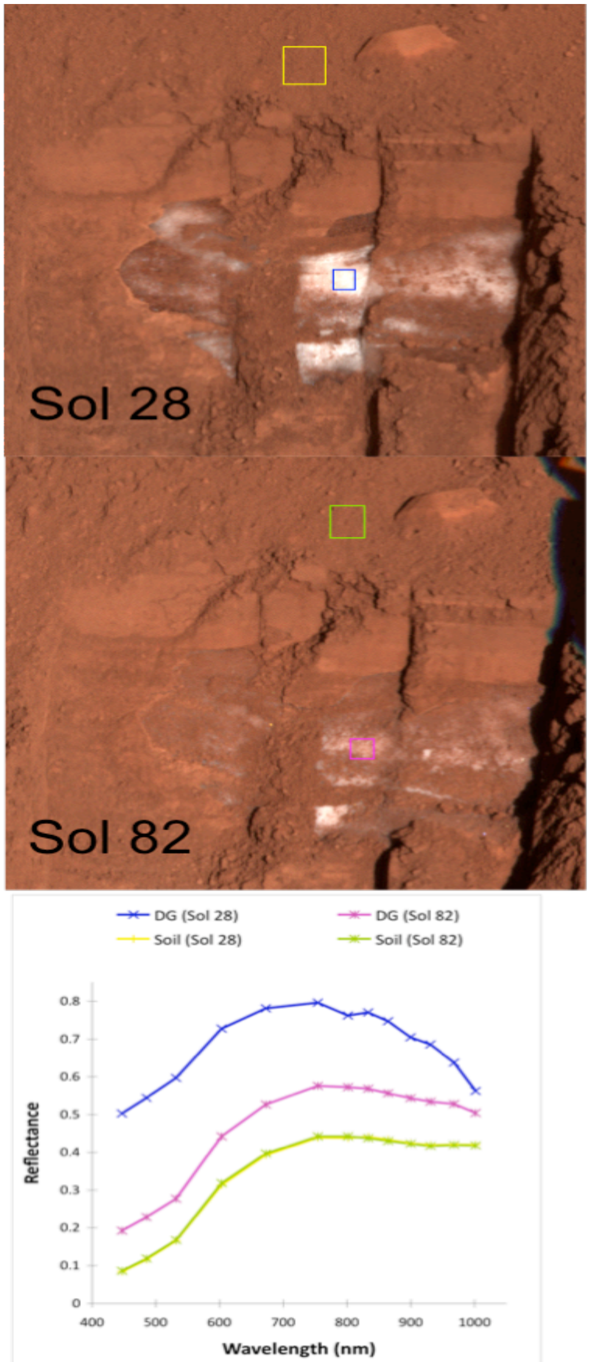

Figure 2. Color (RA, RB, RC) and spectral changes in the Dodo-Goldilocks Trench between Sol 28 (Token 132F0) and 82 (Token 196C0). Observations were collected at the same time of day to minimize viewing geometry, illumination, and calibration differences.

No evidence for high albedo salt enrichment was measured spectrally in the soils and lag deposits in the Dodo-Goldilocks region.

On Sol 99 the robotic arm scraped the sublimation lag from Dodo-Goldilocks and delivered the sample to the MECA Optical Microscope (OM). Collection of the sample exposed fresh high albedo ice confirming that an optically thick lag deposit of material from within the ice deposit had formed. Sublimation within the exposed area was not uniform. Some high albedo patches remained prominent until the region was disturbed and monitoring ceased (Figure 2). The sublimation rate therefore was either variable and/or the amount of soil varied within the ice deposit.

MECA OM measurements showed no increase in salt concentration in the sample [6], consistent with the spectral results. The sample was depleted in smallest size fraction of materials compared to other samples measured by the MECA OM [6]. This implies that the soil material is the ice deposit has a saltation origin and is not incorporated via airfall or the admixture of non-sorted local materials.

Formation models for Type I ice deposits are still being formulated and will be discussed at the meeting. *However, the lack of evidence for salt residues and the size distribution of materials in the deposit argues against models involving perchlorate-rich brines mobilizing liquids to form these deposits*.

Type II Ice (Snow White-Neverland): Excavation in Wonderland (Snow White trench) revealed an ice/soil mixture with a significantly more soil than at Dodo-Goldilocks based on spectral characteristics. Sublimation of these materials rapidly produced a lag deposit. The Snow White area was selected to be the site where TEGA worked to collect its ice-rich sample [7]. TEGA icy sample collection required periodic scraping and rasping. This produced visible amounts of material that could be measured spectrally from the soil/ice boundary and from inside the ice layer. These soils are consistent spectrally with other soils at the site. Atmospheric vapor deposition is the preferred formation mechanism for Type II deposits.

This work carried out at the Jet Propulsion Laboratory / California Institute of Technology under contract with NASA.

References: [1] Lemmon et al. (2009) LPS XL, this volume, [2] Morris et al. (2009) LPS XL, this volume [3] Arvidson et al. (2009) LPS XL, this volume, [4] Shaw et al. (2009) LPS XL, this volume, [5] Mellon et al. (2009) LPS XL, this volume, [6] Pike et al. (2009) LPS XL, this volume. [7] Boynton et al. (2008) Fall AGU.