EPSC Abstracts
Vol. 5, EPSC2010-715, 2010
European Planetary Science Congress 2010

Multi-Spectral Observations of the Phoenix and MER Landing Sites: Characteristics of Surface and Subsurface Ice, Rocks, Soils, and Coatings

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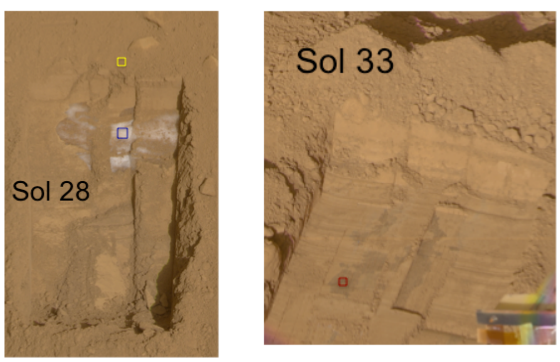
1. Introduction

Multi-spectral imaging is a key tool for assessing material diversity and mineralogy in-situ on the surface of Mars. The Surface Stereo Imager (SSI) on Phoenix Lander lander collected images for 151 Martian days (Sols) including over 100 multi-spectral observations. [1,2]. Meanwhile, the MER rovers Spirit and Opportunity have collected multi-spectral images at a variety of terrain types over the last six years [e.g. 3,4]. This work compares the spectral characteristics of surface / subsurface ice-rich materials, rocks, soils, and rock coatings at the Phoenix landing site with materials elsewhere on Mars.



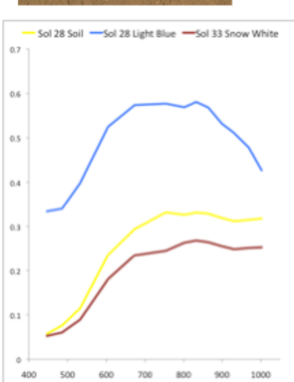


Figure 1. Sol 28 image of the Dodo-Goldilocks trench, Sol 33 image of the Snow White Trench, and the spectra extract from identified locations. Type I ice rich material is characterized by a high albedo and convex spectral structure while Type II material is spectrally similar to nearby soils.

2. Subsurface materials at the Phoenix Landing Site

Two types of ice-rich materials were exposed in the subsurface of the Phoenix Lading site [1,2]. Type 1 is mostly pure ice with very small amount of Martian soil. This type of ice was exposed at the Dodo-Goldilocks trench and allowed to sublimate over the course of the mission. Type 2 material is ice cemented soil that is matrix supported and is consistent with vapor deposition of water ice into soil. Locations and extracted spectra of these materials are shown Figure 1. In addition to ice rich materials cloddy materials were exposed by Phoenix that were spectrally consistent with the soils in the area. Like most Martian spectra of soils in this wavelength region, the spectra shape of the clods were dominated by the nano-phase iron oxides.

There is no spectral evidence for highly concentrated salt brines at the Phoenix site. Sublimation of Dodo Goldilocks did not leave behind a high albedo salt residue rather material that spectrally was similar to nearby sols. Additionally there was no evidence of salt horizons in soil or concentrated under rocks. This argues against large-scale mobility of high concentration brines. However, salts and thin films of water may be involved in the formation of coatings and clods.

3.1 Formation of Subsurface Ices

Heterogeneous ice formation is required to explain the observations at the Phoenix Site. At Dodo-Goldilocks a mechanism of getting pure ice in the subsurface is required. Snow White however is consistent with vapor diffusion processes that are expected at high latitudes. Formation mechanisms involving high concentration percholorate brines are not likely given the low perchlorate concentration [5] and the lack of a salt lag on the sublimated deposit. This suggests that heterogeneous process involving current climate conditions such as vapor diffusion ice lens/needles or seasonal snow burial may be involved.

4. Rock and Soils

As shown in Figure 2, rocks and soil show little spectral variability at the Phoenix landing site. The spectra dominated by nano-phase iron oxide. The rock coatings and cemented clods indicate mobilization of salts by small amounts of water. This is consistent with thin films of water, perhaps in the subsurface. The presence of wide spread coating on rocks makes it problematic for in situ or orbital remote sensing to identify the underlying mineralogy.

Rock coatings are not limited to the Phoenix site. Martian rocks frequently exhibit relatively high albedo ferrous iron-rich coatings that are the product of local alteration. These coatings are not simply the result of atmospheric dust landing on rocks. For instance, the Spirit rover studied the coated rock Mazatzal and found that the coating had elevated sulfur and chlorine when compared to local soils [6]. Finally the distribution of rock coatings at a given location is highly variable. Rocks with and without coatings can be next to each other. Similarly a single rock may only be partially coated. However, the Phoenix site has many more coated rocks than other locations on Mars indicating that the coating process is more perhaps rapid at high latitude, better preserved, or related to specific climatic conditions. The process (or processes) that forms rock coatings on Mars is unknown in detail but is thought to involve small amounts of liquid water at the soil / rock interface. A possible hypothesis is that that rock coatings form in the subsurface at the rock/soil interface. The rock is then exhumed by erosion or cyroturbation in regions where polygons are forming. Subsequent aeolian activity erodes the coating on exposed rocks. The distribution of coated rocks thus becomes a complex function of rate of burial and exhumation, water availability in the subsurface, wind direction, and availability of material to abrade the coatings when exposed.

Acknowledgements

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

References

[1] Smith et al. H2O at the Phoenix Landing Site, Science, 325: 58-61 2009. [2] Blaney, D. L., et al. Multi-Spectral Imaging of the Phoenix Landing Site: Characteristics of Surface and Subsurface Ice, Rocks, and Soils LPS XL, Houston, TX, (2009). [3] Bell, J.F. et al. (2004) Pancam multispectral imaging results from the Spirit rover at Gusev Crater, Science, 305, 800-806 (2004) [4] Farrand, W. H. Visible and near-infrared multispectral analysis of rocks at Meridiani Planum, Mars by the Mars Exploration Rover Opportunity, J. Geophys Res Planets, 112, E06S02, 10.1029/2006JE002773. (2007). [5] Hecht et al., Detection of Perchlorate and the Soluble Chemistry of Martian Soil at the Phoenix Lander Site, Science 325: 64-67, 2009. [6] Gellert et al, Science, 305, 829-832 (2004).

Figure 2. Example rock and soil spectra from the Phoenix Landing site. Spectra are dominated by nano-phase iron oxides. Soils and rocks are spectrally similar with the key difference being slight albedo changes.