Exploring the Effects of Dust Coatings and Shock Pressures on Thermal Infrared Spectra.

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Introduction. Dust coatings on rocks obscured the underlying rock surfaces at the Mars Pathfinder landing site and made it difficult to obtain pristine visible/near-infrared reflectance spectra and chemical measurements **[1]**. Such dust coatings also affect the ability of thermal infrared (TIR) spectra (such as that provided by TES and future lander (mini-TES) and orbiter multispectral imaging systems (THEMIS) **[2]**) to reveal accurately the mineralogy of rocks and soils. Similarly, high shock pressures from impact events cause crystalline disorder in important minerals such as pyroxene and feldspar that also affects their TIR spectra and complicates spectral interpretation of shocked impact materials **[3,4]**.

Methods. We are acquiring hemispherical reflectance measurements (using the UH Nicolet 5SXC FTIR spectrometer; 8 cm^{-1} spectral resolution from ~7-14 μm) and emissivity measurements (using the ASU Mattson Cygnus 100 FTIR, 4 cm^{-1} spectral resolution from ~7-20 μm) of basaltic andesite substrates (SP Flow, AZ) coated with variable thicknesses of Pahala ash (South Point, HI), the JSC-1 Mars soil analog (Puu Nene, HI), terrestrial loess from Washington State, two varieties of fine-grained (≲5 μm) commercial pottery clays (Redart and OM-4 ball clay), and soon 0.5 μm and 1.2 μm aluminum oxide particles. We also used an ASD FieldSpec spectrometer in the laboratory to obtain reflectance spectra (400-2500 nm) of the JSC-1 dust coatings at UH. The coatings (wet-sieved to ≲3 μm for the JSC-1 and Pahala ash samples) were deposited on the basalt substrates using an airfall technique within an enclosed chamber, and thicknesses were estimated at 25 locations on the sample across a 5x5 grid using a vertically-calibrated microscope. These estimates are hampered by the effects of particle clumping, which leads to uneven surface area coverage and large standard deviations in the average estimated thickness. Surface area coverage was estimated by applying a mathematical variance operator on digital microscope images of the coated samples acquired at UH.

Anorthosite samples from the Stillwater Complex **[5]** are scheduled for shock experiments in late May, 1999 using the 25-mm barrel gun at JSC. Shock levels will be acquired at 18, 25, 30, 35, and >40 GPa and provide sufficient recovered samples (~500mg) to allow acquisition of TIR spectra to document the increased disordering effects and subsequent loss of spectral details with increasing shock pressure. Emission spectra obtained at the ASU facility will be presented.

Results. Figure 1 shows emission and reflectance spectra of JSC-1 coatings on SP basalt. These spectra demonstrate that the spectral features of the uncoated basalt substrate are sequentially replaced with those of the coating material as coating thickness increases. The reduction in spectral contrast in the 8-14 μm region appears to be linearly related to coating thickness until about 80μm, where further differences between coated and uncoated surfaces are not observed, as quantified in Figure 2. More work is required to refine this “saturation thickness” value **[6]**.

Figure 3 shows the results of the ASD laboratory reflectance spectra for JSC-1 coatings of thicknesses from ~17 to ~122μm. Here, the spectral features of the underlying basalt are also sequentially replaced with those of the coating. However, in the visible and near-infrared fine-grained particles are brighter due to greater surface scattering compared to larger grains **[7]**, which leads to an *increase* in the spectral contrast of the underlying basalt as coating thickness increases. The contrast reversal near 480 nm is a result of Fe^{3+} absorptions in the near-UV/visible associated with greater amounts of palagonite-rich JSC-1 soil.

ACKNOWLEDGEMENTS. We thank K. Horton (HIGP, UH) and V. Hamilton (ASU) for assistance with the use of laboratory spectrometers, M. Ramsey (ASU) for use of the dust deposition chamber, R. Nelson (JPL) for the Al-O particles, L. Ely (Cent. Washington Univ.) for the loess sample, C. Allen (JSC) for the JSC-1 sample, and L. Haskin and B. Jolliff (Washington Univ.) for the Stillwater anorthosite samples.

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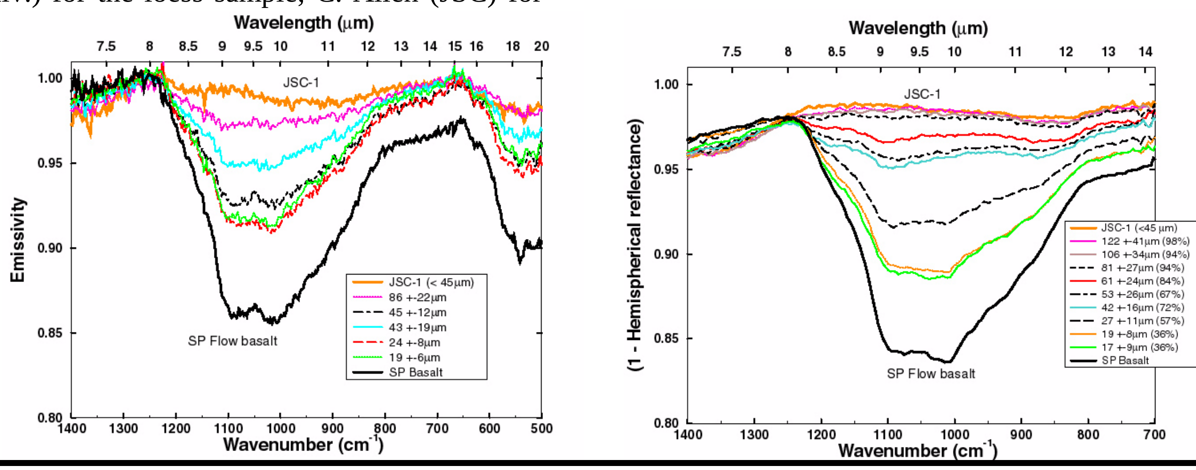

Figure 1. (*Left*) Emissivity spectra (7-25 μm (400-1400 cm^{-1})) and (*right*) inverted reflectance spectra (7-14 μm (700-1400 cm^{-1})) of SP basalt with coatings of JSC-1. Coating thickness shown in legend; areal surface coverage shown in parentheses for reflectance spectra.

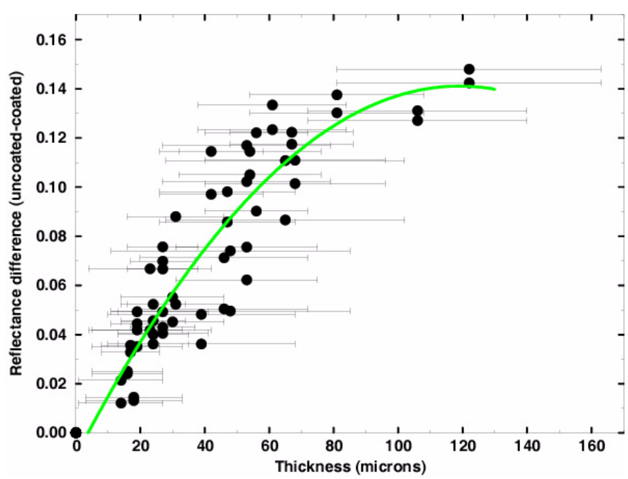

Figure 2. Reflectance differences between coated and uncoated samples as a function of coating thickness, showing a linear correlation until ~80μm thickness. Curve is quadratic fit to the data.

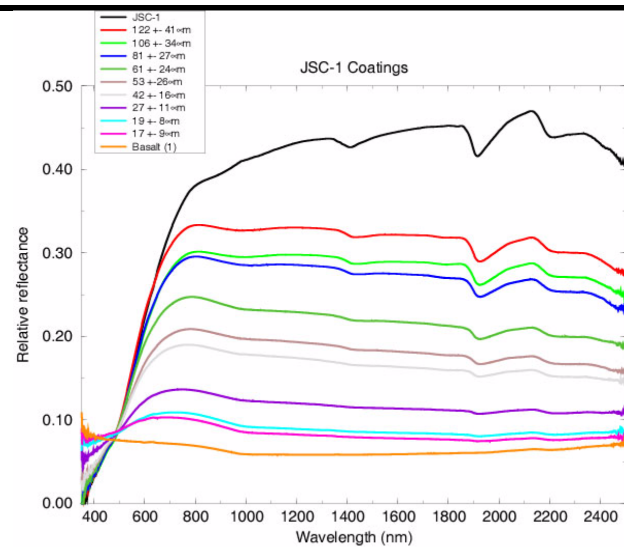

Figure 3. Laboratory reflectance spectra (400-2500 nm) from ASD spectrometer of SP basalt with coatings of JSC-1, showing increase in spectral contrast with increased coating thickness.