REFINEMENT AND DISCOVERY WITH MINI-TES SPECTRA IN GUSEV CRATER. S. W. Ruff[1] and J. L. Bandfield[2], [1]Arizona State University, School of Earth and Space Exploration, Tempe, AZ 85287-6305, steve.ruff@asu.edu, [2]University of Washington, joshband@u.washington.edu.

Introduction: Thermal infrared spectra (~340 – 2000 cm^{-1}) from the Miniature Thermal Emission Spectrometers (Mini-TES) onboard the Mars Exploration Rovers *Spirit* and *Opportunity* are used to characterize the mineralogy of rocks and soils and the constituents of the atmosphere. As described by [1], Mini-TES spectra show features attributable to dust in various forms that complicate their interpretation. One case involves the accumulation of dust on exposed optical components of the instrument. Here we discuss the accuracy of a previously developed correction relative to the provisional correction presented by [1] and how it impacts previous interpretations. In another case, originally described as "additional downwelling radiance" and thought to be due to atmospheric dust, we now recognize and describe an alternative possibility in which surface dust creates the spectral contribution.

Although Mini-TES spectra have already contributed to a range of discoveries, the thousands of spectra acquired from both rovers provide the opportunity for additional discoveries. We present an example of fortuitous observations that provide an expanded view of the rocks on the plains of Gusev Crater.

Mirror Dust: On sol 420 of the *Spirit* mission, an aeolian event occurred in which dust was blown into the head of the Pancam Mast Assembly that houses the Mini-TES pointing mirror and fold mirror. The spectra measured by Mini-TES in subsequent sols show clear evidence of spectral artifacts that most likely are due to a thin layer of dust deposited on the pointing mirror [1; 2]. The magnitude and phase of the dust spectral features are dependent on the temperature difference between the pointing mirror and the scene, but in most cases cannot be neglected. The strategy developed by [2] to correct Mini-TES atmospheric spectra appears well suited to correcting surface spectra as implemented by Mini-TES team member Amy Knudson (Fig. 1).

The provisional correction developed by [1] yields results that in some cases are comparable to those obtained using the method of [2]. Other cases are significantly different. For example, [3] presented interpretations of Mini-TES spectra corrected using the method of [1]. The results for the class of rocks known as Comanche were especially problematic. Application of the correction of [2] shows significant differences that likely will change the interpretation of this class.

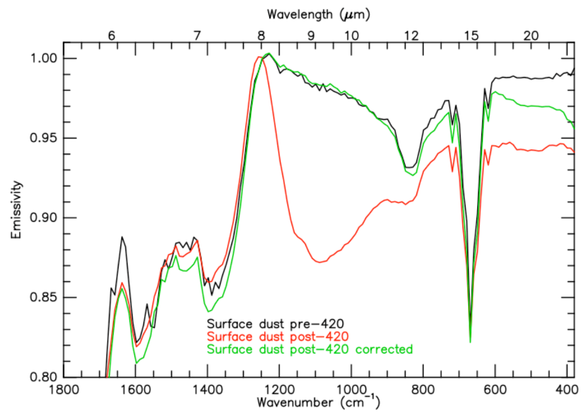

Figure 1. Demonstration of the accuracy of mirror-dust correction from [2]. Two different occurrences of thick surface dust measured before (black) and after (red) the sol 420 mirror-dusting event. In green is the corrected version of the red spectrum.

Dust Coatings: Under certain conditions, Mini-TES spectra of rocks and soils appear to contain features similar to those of atmospheric dust [1; 4]. But the physics by which atmospheric dust contributes spectral features to surface observations is difficult to reconcile. An alternative to the downwelling radiance hypothesis of [1] involves an optically thin layer of dust on surfaces rather than dust in the atmosphere. The spectral contributions may be analogous to those produced by mirror dust in which a thin layer of dust acts as an absorber or emitter, modifying the spectral features of the substrate. This spectral behavior is different than that of thick accumulations of dust found at both landing sites and across the planet that completely obscures the substrate. Instead, an optically thin layer of dust could conceivably radiate at a temperature different than that of the substrate in a manner akin to a thermal gradient [e.g., 5; 6].

The spectral character of atmospheric dust and mirror dust is notably similar. Using factor analysis and target transformation (FATT) of Mini-TES data from surface targets in Meridiani Planum, [4] identified a spectral component that resembles atmospheric dust. But importantly, it does not display the features of atmospheric CO_2. Because the dataset incorporated spectra that precede substantial mirror dust contamination, we suggest that the putative atmospheric dust spectral shape is instead due to optically thin surface dust rather than mirror dust, but with similar effects. This explanation is more plausible than one involving downwelling radiance, but is unlikely to substantially alter the features of corrected spectra or change resulting interpretations.

Fortuitous Discovery: Of the thousands of observations made with the Mini-TES instruments, many are untargeted. For example, a spot of ground in front of the rover is routinely measured to supply upwelling radiance estimates to support atmospheric observations. While Spirit was parked on the Jibsheet Ridge and Larry's Lookout outcrops on Husband Hill, the ground measurements fortuitously observed the distant plains to the northwest due to the substantial upward pitch of the rover. The resulting spectra clearly resemble the olivine-rich Adirondack Class basalts, an unexpected result given the dominance of spectrally distinct soil and dust on the plains (Fig. 2).

A similarly fortuitous observation of the plains to the northeast shows a similar result, demonstrating for the first time that Adirondack Class basalts occur on both sides of the Columbia Hills (Fig. 3). In all cases, these are high emission angle measurements of distant surfaces that presumably are dominated by radiance from the more steeply angled facets of rocks in the field of view rather than the horizontal surfaces of dusty soil. Such high emission angle observations from TES, THEMIS, and future instruments may provide clearer views of the rock component in other locations on the planet.

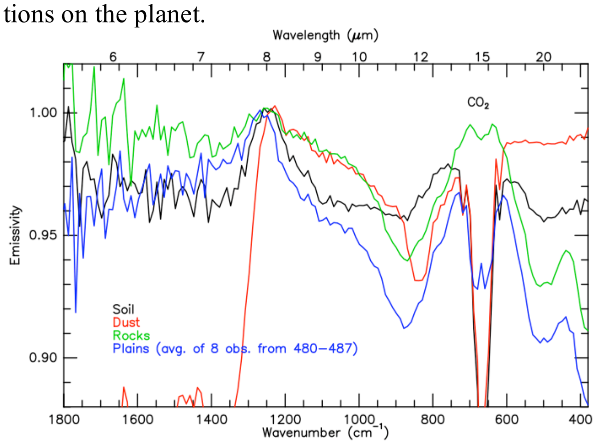

Figure 2. Example of a fortuitous high-emission-angle observation of the Gusev plains (blue) that clearly resembles the olivine-rich Adirondack Class rocks (green) rather than the dominant soil (black) and dust covered (red) surfaces.

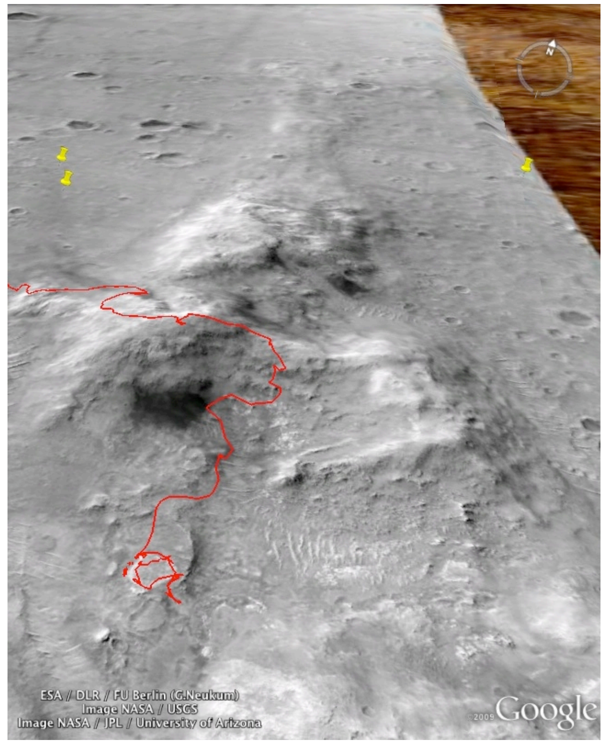

Figure 3. HiRISE perspective view of the Columbia Hills and *Spirit* traverse (red). Yellow markers indicate locations measured by Mini-TES at high emission angles while in the hills. In all cases, the spectra clearly indicate the presence of olivine-rich Adirondack Class basalt, expanding the known distribution of this rock unit and demonstrating the remote identification capabilities of Mini-TES.

References: [1] Ruff, S. W., et al. (2006), *JGR*, 111, E12S18, doi:10.1029/2006JE002747. [2] Smith, M. D., et al. (2006), *JGR*, 111, E12S13, doi:10.1029/2006JE002770. [3] McSween, H. Y., et al. (2008), *JGR*, 113,E06S04, doi:10.1029/2007JE002970. [4] Glotch, T. D., and J. L. Bandfield (2006), *JGR*, 111, E12S06, doi: 10.1029/2005JE002671. [5] Salisbury, J. W., et al. (1994), *JGR*, 99, 11897-11911. [6] Henderson, B. G., et al. (1996), *JGR*, 101, E6, 14,969-914,975.