MARS ANALOGUE FIELD SPECTROSCOPY: BUILDING REAL-WORLD EXPERIENCE FOR THE MARS 2003 ROVER MINI-TES. B. T. Greenhagen¹, L. E. Kirkland², K. C. Herr³; ¹University of Minnesota, Minneapolis, gree0455@umn.edu; ²Lunar and Planetary Institute, Houston, kirkland@lpi.usra.edu; ³The Aerospace Corporation, kenneth.c.herr@aero.org.

Introduction: The 2003 Mars Exploration Rover science strategy is to identify promising targets using the visible/near-infrared imaging Pancam and the thermal infrared spectrometer Mini-TES. The rover would then traverse to those targets for more detailed examination. Team members will select sites using target morphology and color from Pancam, and interpretations of the mineralogy using Mini-TES. This strategy requires low ambiguity, near real-time interpretations of Mini-TES data.

Field spectrometer measurements from a rover perspective differ significantly from both laboratory and airborne measurements. Here we detail complications found in unique field measurements that used instrumentation very similar to the Mini-TES, and implications for identification of minerals using Mini-TES.

Data: Our instrumentation measures with the highest fidelity to the Mini-TES of any field instrument available. We use the Model 100 (M100) Block Engineering Fourier transform infrared interferometers. Table 1 compares the instruments.

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<tbody>
<tr>
<td>FOV (mrad)</td>
<td>8 or 20</td>
<td>9</td>
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<tr>
<td>Sampling (cm⁻¹)</td>
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<td>10</td>
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<tr>
<td>Range (µm)</td>
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<td>5-25</td>
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<tr>
<td>Height (m)</td>
<td>2-3</td>
<td>1.4</td>
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FOV=field of view, sampling=spectral sampling interval, range= spectral range, height=height of FOV

Complications: There are numerous sources of ambiguity when measuring spectra in the field, however, when looking at rocks a prime difficulty is reflected downwelling radiance. Downwelling radiance can affect the spectral character by imparting the spectral character of the downwelling radiance onto the measured target spectrum. The contribution differs from the airborne, laboratory, and field perspectives, and with the surface texture and temperature.

For example, Figure 1 compares field data with typical laboratory data used for interpretation. It shows the same field spectrum processed using different underlying assumptions. The different results illustrate the importance of understanding how to treat the data.

**Figure 1:** Using Field Data. The upper two traces show the same field spectrum, using different methods [1]. The lower trace is a typical laboratory spectrum used to identify field measurements [3, “quartz1.c”]. Atmospheric bands cause the fine structure in the field spectra.

**Figure 2:** Line-sight downwelling. If a material is specular light will reflect off the material like a mirror. The downwelling measured is only representative of one point in the sky. D1,R1=sky downwelling, reflected sky downwelling; D2,R2=cloud downwelling, reflected cloud downwelling; D3,R3=mountain downwelling, reflected mountain downwelling.
Hemispheroidal downwelling. The hemispheroidal downwelling for diffuse targets can be readily measured using a high reflectance, rough-surfaced target of known spectral signature. This is used to compensate the geologic target for the reflected downwelling component.

Line-sight downwelling. Smooth rocks can have both diffuse and specular components. The specular component is significant in very smooth coatings such as desert varnish. Unfortunately, the measurement and conversion protocols for the specular component of these materials are currently poorly understood. In theory, one would measure low angle (near horizon) line-sight downwelling for distant objects and a high angle (near zenith) for nearby objects.

Temperature. We have also found that temperature contrast between the target and atmosphere is important. In an ideal situation the target would be hot and the atmosphere very cold. This causes the downwelling radiance to have less significant contribution to the total radiance of the target. Likewise, a cooler surface and/or warmer atmosphere results in a more significant downwelling contribution.

Implications for Mini-TES: All of the aforementioned complications are important for Mars, where we expect to find both diffuse (rough) materials and smooth coated rocks.

Downwelling radiance. The 2003 Mars rover does not carry a diffuse, high-reflectance target for Mini-TES. Thus the spectral characteristics of targets of convenience (i.e. solar panels, landing materials) must be investigated. If no suitable target can be found, the diffuse downwelling radiance will have to be estimated from line-sight downwelling measurements. That is, we have to simulate the Figure 4 “diffuse” spectrum from the Figure 4 “sky” spectrum. It is currently unclear whether this is practical. This approach will also need to consider that line-sight variation on Mars may be greater from dust loading and water ice clouds.

Temperature. The temperature factor illustrates the importance of choosing targets in areas of low topographic relief. A target near the base of a cliff would have half of the downwelling radiance hemisphere filled with warm rock, further increasing the downwelling contribution to the total radiance of the target. While it may be possible to compensate for this increased downwelling component it increases the interpretation uncertainties.

Conclusion: Our field experience has made clear several potential ambiguities related to downwelling radiance. A means of measuring the hemispheroidal downwelling must be found. In addition, development of a technique that incorporates measurements of both line-sight and hemispheroidal downwelling would enable more accurate interpretations. Also, to reduce the relative contribution from downwelling radiance, measurements should be made in areas of low topography. Development and testing of these procedures and an improved understanding of the required measurement protocols and uncertainties requires measurement in the field of data with high fidelity to the Mini-TES.