Improved Spectrometric Capabilities for In-Situ Microscopic Imagers
R. G. Sellar¹, J. D. Farmer², P. Gardner¹, P. Staten³, A. Kieta⁴, and J. Huang⁵

¹Jet Propulsion Laboratory (glenn.sellar@jpl.nasa.gov), ²Arizona State University, ³Weber State University, ⁴California State Polytechnic University, ⁵California Institute of Technology

Objectives

- Assess the origin of rocks based on the interplay of textural and compositional information at the hand-lens scale
- Enable assessments of habitability based on observations of mineralogy at a scale relevant to microbial life
- Advance beyond the capabilities of current and planned microimagers:
  - Acquire reflectance as a function of wavelength only, rather than as a function of wavelength and illumination angle
  - Extend spectral range into the infrared
  - Increase the number of spectral bands

Constraints for In-Situ Instruments

- Compact
- Rugged
- Highly-reliable
- Limited or no sample preparation

Multispectral Microscopic Imager: 3-band visible version

MER Microscopic Imager (engineering model) with end-green-blue LEDs, used to demonstrate the effects of illumination approaches.

Reflectance as a function of wavelength only, rather than wavelength and illumination geometry

Separate, single-band LEDs lead to spectral artifacts.

Use of multi-band LEDs provides consistent illumination.

Three-band false-color composite, composed of three of the eight bands acquired: 525 nm (represented in blue), 805 nm (represented in green) and 1300 nm (represented in red). Samples are (clockwise from top left): rhodochrosite, goethite, halite, red hematite, grey hematite, and andesite, with olivine in the center, on a background of palagonite. Field-of-view is 32 x 40 mm with 62.5 μm spatial sampling.

Multispectral Microscopic Imager: 8-band VIS/NIR/SWIR version

<table>
<thead>
<tr>
<th>Center wavelengths (nm)</th>
<th>525</th>
<th>660</th>
<th>735</th>
<th>805</th>
<th>850</th>
<th>940</th>
<th>975</th>
<th>1300</th>
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</table>

Budget constrained the design to use commercial-off-the-shelf LEDs. Rather than a single LED, the eight bands are provided by three separate LEDs, each with three or four wavelengths (the illuminator shown here employs two of each type). Bandwidths range from 20 to 80 nm (full-width-at-half-maximum). The focal-plane-array for this version is substrate-removed InGaAs (uncooled), sensitive from visible to 1700 nm wavelengths.

Eighth-band reflectance spectra extracted from the multispectral image-cube. Each spectrum displayed here is the mean over the pixels indicated by the key shown in the lower right.

Images of hematite concretions (from Snow Canyon, UT) on a background of JSC MARS-1 soil simulant. Image on the left acquired with panchromatic (white) illumination. Image on the right is a three-band composite acquired with illumination from a three-wavelength RGB (660, 525, 468 nm) LED. Field of view is 30 x 30 mm with 30 μm spatial sampling.