Quantitative Mineral Abundances in Gale Crater Using THEMIS

Rebecca J. Smith and Philip R. Christensen, rebecca.jean.smith.1@asu.edu
School of Earth and Space Exploration, Arizona State University

1. Motivation and Background
This study attempts to derive quantitative mineral abundances from the central mound of Gale Crater using thermal infrared (TIR) datasets. The mound has been studied using datasets from the Compact Reconnaissance Imaging System for Mars (CRISM) in the visible and near infrared (VISNIR) [1, 2]. However, many factors make it difficult to obtain quantitative results at these wavelengths. Such issues are simplified at TIR wavelengths where surfaces are assumed to combine linearly. Thus far, TIR studies of the central mound have been discouraged because of the low spatial resolution of the Thermal Emission Spectrometer (TES) instrument (3 km x ~6 km pixel), the low spectral resolution of the Thermal Emission Imaging System (THEMIS) (9 spectral bands) despite the high spatial resolution (100 m/pixel) of the instrument, and the steep elevation change over the height of the mound [3]. Significant slopes can affect the atmospheric correction of spectral data due to varying atmospheric thickness. This study attempts to circumvent these issues by using multiple atmospheric corrections of one THEMIS IR image for spectral analysis, and by using an iterative linear deconvolution method.

2. Methods
- Used JMARS [4] to view and/or select CRISM, TES and THEMIS datasets
- Used TES data from different elevations to produce two versions of an atmospherically corrected THEMIS IR spectral cube 118380009 [5]
- Averaged atmospherically corrected spectra from 7x7 pixel areas in the region of interest which correspond to specific compositional units studied by CRISM
- Attempted deconvolution of averaged THEMIS spectra using bands 3 - 9 and a non-negative least squares fitting algorithm

3. THEMIS Data
Decorrelation stretches of THEMIS image 118380009. These stretches highlight band depth (compositional) differences in the image by comparing three bands at once. THEMIS bands range from 6.78 - 14.88 µm with ~1 µm steps

4. THEMIS Atmospheric Correction
Figure 1 (a) 100 m THEMIS day IR mosaic over Gale Crater. Boxes 1 & 2 in training region correspond to TES data used in atmospheric correction. Colored dots indicate locations of 7x7 pixel areas that produced spectra in Figures 2 and 3, and that correspond to similarly colored letters in (b). Red and black ines show locations of DTM HRSC elevation profiles for the training region and the region of interest (ROI), respectively.

5. Results
Figure 2 (above). Atmospherically corrected spectra of locations from ROI (bottom) compared to spectra of sulfate (kieserite) and clay (nontronite) (top). Emissivity minima at 8.56 and 9.35 correspond nicely. Spectra offset for clarity.

6. Discussion
- Elevation-derived atmospheric correction has thus far produced spectral shapes that suggest THEMIS detection of sulfate and phyllosilicate minerals that are in agreement with mineralogy determined by CRISM
- The detection by THEMIS suggests that these minerals are present in abundances greater than the detection limit of THEMIS (~10-15%)
- Next steps: deconvolution modeling and mineral abundance maps

7. References

8. Acknowledgements
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