THEMIS MULTISPECTRAL ANALYSIS OF PROPOSED PALEOLAKE BASINS IN THE AEOLIS QUADRANGLE OF MARS. K. R. Stockstill[1], J. E. Moersch[1], H. Y. McSween, Jr.[1], P.R. Christensen[2], [1]Department of Earth and Planetary Sciences, University of Tennessee, 306 Earth and Planet. Sci. Bldg., Knoxville, TN 37996, kstockst@utk.edu, [2]Department of Geological Sciences, Arizona State University, Tempe, AZ 85287.

Introduction: Several geomorphic studies have proposed the existence of paleolake basins on Mars [*e.g.*, 1,2]. A list of 179 proposed paleolake basins in impact craters was compiled with corresponding geomorphic evidence for each basin [1]. Previously, we conducted a TES study [3] to search for small (~5 km-scale) exposures of evaporite minerals within the 80 largest putative paleolake basins from this list [1]. In that study, seven basins displayed one or more surface spectral units distinct from their surroundings. Linear deconvolution and newly-developed spectral indices methods were used to analyze spectral units from these basins. The deconvolution routine never used evaporite spectral endmembers in credible amounts (i.e., not > 10-15% [4]) and the spectral indices methods did not detect evaporite minerals for any spectra of identified spectral units [3].

While our previous work did not detect evaporite minerals on the scale of a TES footprint (3x5km), the enhanced spatial resolution of the Thermal Emission Imaging System (THEMIS) aboard the Odyssey spacecraft may provide a way to search for potential aquous mineral deposits on a smaller scale. THEMIS acquires thermal infrared images at 100 m/pixel resolution in nine spectral bands. Because its higher spatial resolution, THEMIS is best considered as a spectral unit mapper whereas, due to its higher spectral resolution, TES would typically be better at mineral identification. If potential deposits can be detected and mapped, TES spectra of the same area could be examined for subtle spectral features. Similar techniques have been used to map and identify compositions of other outcrops on Mars [e.g., 5,6].

Methods: This project uses THEMIS data to analyze proposed paleolake basins, including Gale and Gusev Craters, within the Aeolis quadrange of Mars. THEMIS daytime infrared image cubes covering these basins have been compiled and were initially filtered for Local Solar Time (LST). Because we are examining basins between 0º and 30º south of the equator, applying a LST filter provides an efficient means for eliminating data with decreased signal-to-noise ratio. Data was further filtered for minimum surface temperature, because derived emissivity data are only considered trustworthy for surfaces above 240K [6,7]. Each THEMIS image cube meeting this criterion is geographically projected using software written at Arizona State Univeristy.

A radiance offset correction must be applied to these image cubes due to an additive contribution from downwelling radiance from the atmosphere, as well as an additive instrument calibration error [6]. A geologic feature (such as a crater) that can be assumed via photogeologic arguments to have uniform emissivity spectra but a relatively large range of temperatures is defined as a test area. Because of the radiance offset problem, uncorrected emissivity spectra taken from within the chosen test area are not generally uniform. A minimization routine after [6] calculates the radiance offset values for each band that would produce uniform emissivity spectra within the test area. These derived offsets are then applied to each pixel within the radiance image cube. This produces 1) a corrected radiance image cube, 2) a corrected brightness temperature image and 3) an emissivity image cube that still contains atmospheric absorptions.

A principal components analysis (PCA) is applied to the corrected emissivity image cube to enhance surface spectral variations. Spectral units are identified within a PCA (single- and/or 3-band) image and regions of interest (ROIs) are defined on distinct surface units. The high spatial resolution of THEMIS data may allow identification of spatially-confined deposits of aqueous minerals.

Atmospheric removal is performed using the technique of [6]. First, an test area of a spectrally homogeneous area on the THEMIS emissivity cube is defined as an ROI and a mean THEMIS spectrum is collected. This same ROI is overlain on a TES hyperspectral cube [3] and a mean TES spectrum is obtained. The mean TES spectrum is deconvolved using the method of [8] and the removed atmosphere spectrum is convolved to THEMIS spectral bandpasses for bands 3-9. Emissivity value for bands 1&2 for all pixels in the scene are run through an Internally Averaged Relative Emissivity (IARE) routine to produce an average emissivity value for the entire scene. Because carbonates have not been observed on the scale of a THEMIS scene [3, 9, 10 and others], we expect this average scene emissivity value to be a good estimate of the atmospheric emissivity value for bands 1&2. The IARE-derived emissivity values for bands 1&2 are concatonated to the TES-derived emissivity values for bands 3-9 to produce a THEMIS spectral resolution atmosphere-removed emissivity spectrum. A routine then calculates a multiplicative correction term necessary to force the original mean THEMIS ROI spectrum to match the atmosphere-removed emissivity spectrum. Finally, the multiplicative correction is applied to each pixel in the image, producing at atmosphere removed THEMIS emissivity image.

Finally, the ROIs defined in the PCA image can be overlain on the atmosphere-free emissivity data cube and mean ROI THEMIS spectra are collected. The mean ROI THEMIS spectra can be examined. In addition, spectra from the TES pixel or pixels corresponding to the outcrop/deposit are collected, allowing for linear deconvolution and application of the indices methods to the TES spectra [3].

Results: The brightness temperature image from the radiance offset correction step for THEMIS image I0081002 in Gusev Crater is displayed in Figure 1a. The image bisects the crater and covers some external terrain to the north and south. It includes major thermophysical and morphological units mapped previously [11] and the *Spirit* MER landing site.

From the radiance offset-corrected emissivity data, a 3-band PCA image was produced and is shown in Figure 1b. Spectral variation is enhanced in this image, facilitating the identification of surface spectral units within the THEMIS image. Distinct surface spectral units include (but are not limited to) the low albedo deposits (in yellows), the north crater floor (in reds and purples), the south crater floor (in blues) and the mesa deposits (in greens within crater). The north crater floor unit corresponds to the wrinkled unit described by [11] and the south crater floor unit corresponds to the plains unit described by [11]. The mesa unit and the low albedo deposits bear the same names as in [11].

We are currently working to determine the causes of the spectral variations seen in Figure 1b. In addition, we are applying these methods to additonal basins within the Aeolis quadrangle. Detailed mapping and compositional information for spectral units within Gusev Crater and other craters within Aeolis quadrangle will be discussed in this poster.

References: [1] Cabrol & Grin (2000) *Icarus, 149, 291-328*. [2] Forsythe & Zimbelman (1995) *JGR, 100,* 5553-5563. [3] Stockstill *et al*. (2005) *JGR, accepted*. [4] Christensen *et al.* (2001) *JGR, 106, E10, 23823–23871*. [5] Christensen *et al*. (2003) *Science, 300, 2056-2061*. [6] Bandfield *et al*. (2004) *JGR, 109, E10, E10009*, doi:10.1029/2004JE002290. [7] Bandfield & Smith (2003) *Icarus, 161, 47-65*. [8] Smith *et al*. (2001) *JGR, 105, 9589-9608*. [9] Bandfield (2002) JGR, 107, E6, 5042-5061. [10] Bandfield *et al.* (2000) *Science, 287,1626-1630*. [11] Milam *et al.* (2003) *JGR, 108, E12, 8078,* doi:10.1028/2002JE2023.

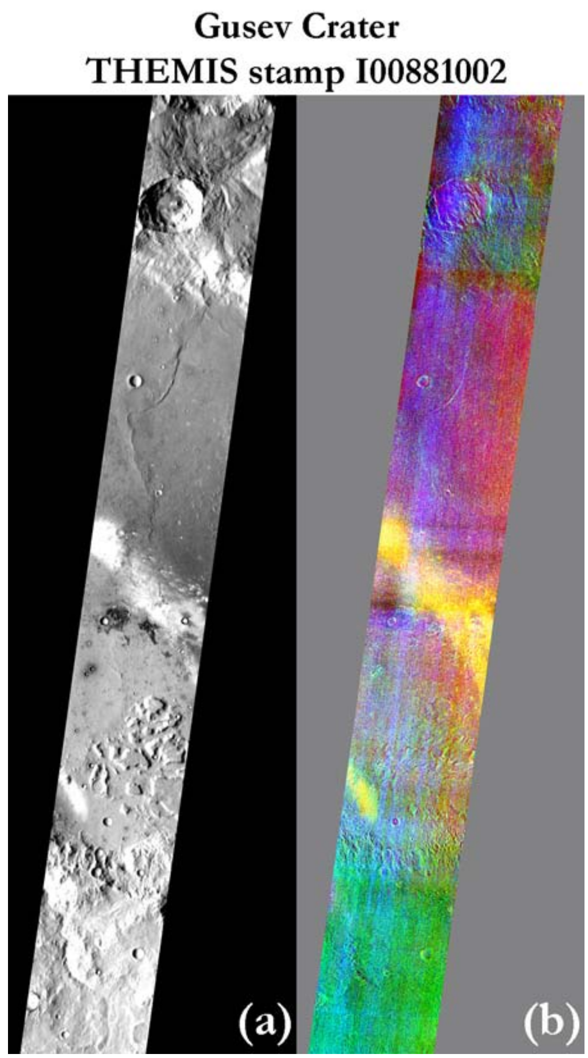

Figure1: (a) Corrected brightness temperature image produced by the radiance offset correction procedure. **(b)** A 3-band PCA image produced from the radiance offset corrected emissivity cube, on which ROIs would be defined to outline surface spectra units.