Detection of Small-Scale Mineral Deposits in Super-Resolved THEMIS TIR Data. C. G. Hughes[1], M. S. Ramsey[1], and J. L. Bandfield[2], [1]Dept. of Geology and Planetary Science, Univ. of Pittsburgh, Pittsburgh, PA 15260 USA, cgh1@pitt.edu, ramsey@ivis.eps.pitt.edu; [2] Department of Earth and Space Sciences, University of Washington, Seattle, WA 98195 USA, joshband@u.washington.edu

Introduction: Super-resolution is the process of improving spatial resolution from that of the original data source (or native) resolution. A first-order approach is the fusion of original data with an additional source, which has the desired resolution. There are a variety of techniques that can be used to fuse these data sets; however, a trade-off has been noted between techniques that are the most visually appealing and those that are most radiometrically accurate [1]. The technique for super-resolution presented here is a modification of an algorithm [2] that was originally tested successfully using multi-resolution data from the Earth orbiting Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument [3]. The spatial and spectral resolution of this instrument is broadly similar to the Mars orbiting Thermal Emission Imaging System (THEMIS) instrument [4]. The current study investigates the applicability of this technique to enhance the THEMIS thermal infrared (TIR) data using the instrument's visible (VIS) data, thus providing radiometrically-accurate data at an improved spatial resolution of 36 m/pixel. This provides an independent approach to traditional sub-pixel deconvolution techniques, and it can be used in the search for small-scale temperature and/or compositional anomalies.

Data and Methods: Data from the THEMIS instrument are organized into two wavelength regions (VIS and TIR), with the VIS having fewer bands but higher spatial resolution. First, VIS pixels in a given image are clustered using the previously described methodology [6]. Upon completion, a tree is created with the co-located TIR pixels on a per-cluster basis, the branches of which represent spectrally-similar pixels.

After completion of clustering, it is possible to super-resolve the image. Pixel values are assigned and then a radiometric correction is applied to the entire image as previously described for ASTER data [6], such that the super-resolved image, when degraded back to the lower resolution, will match the original image. Thus, this approach is radiometrically accurate and fully reversible.

Preliminary Results: The modified super-resolution algorithm has been tested on several THEMIS images. Figure 1 shows a region within the southern crater that was found to have a quartzofeldspathic spectral signature [7]. The super-resolved image is noticeably sharper. The new TIR data also allow more reliable detection of different subpixel-sized surfaces. Figure 2 shows the spectra of the quartzofeldspathic signature used in [7], the spectra of an original pixel (marked in Fig. 1), and the spectra of one of the co-located super-resolved pixels. The super-resolved pixel shows a distinct shift in the location of the absorption minimum towards shorter wavelengths (i.e., more similar to that of the in quartzofeldspathic signature).

Future Work: Super-resolution will next be applied to contemporaneous multi-band THEMIS TIR and VIS data from other locations which have shown spectral diversity. High priority targets, where there is likelihood for small-scale compositional variability, will be chosen for this process first. These areas could include the phyllosilicate or olivine rich areas near Nili Fossae [8, 9], regions of ejecta from small, fresh-appearing craters [10], and the putative chloride deposits [11]. The super-resolved data can either then be compared to Earth analogue sites using data from ASTER, or modeled further using more traditional approaches such as linear spectral deconvolution [10].

References: [1] B. Zhukov et al. (1999), *IEEE Trans. Geol. and RS, 37,* 1212-1226. [2] H. Tonooka (2005), *Proc. SPIE, 5657,* 9-19. [3] Y. Yamaguchi et al. (1998), *IEEE Trans. Geol. And RS, 36,* 1062-1071. [4] P. Christensen et al. (2004), *Space Science Reviews, 110,* 85-130 [5] G. Ball and D. Hall (1967), *Behavioral Science, 12,* 153-155. [6] Hughes et al. (2007), LPSC XXXVIII abs #1810 [7] Bandfield et al. (2004), *JGR, 109*, doi:10.1029/2004JE002290 [8] F. Poulet et al. (2006), *Nature, 438*, 623-627. [9] V. Hamilton et al. (2005), *Geology, 33,* 433-436. [10] S. Wright and M. Ramsey (2006), *JGR, 111,* doi:10.1029/2005-JE002472 [11] M. Osterloo et al. (2008), *Science, 319*, 1651-1654

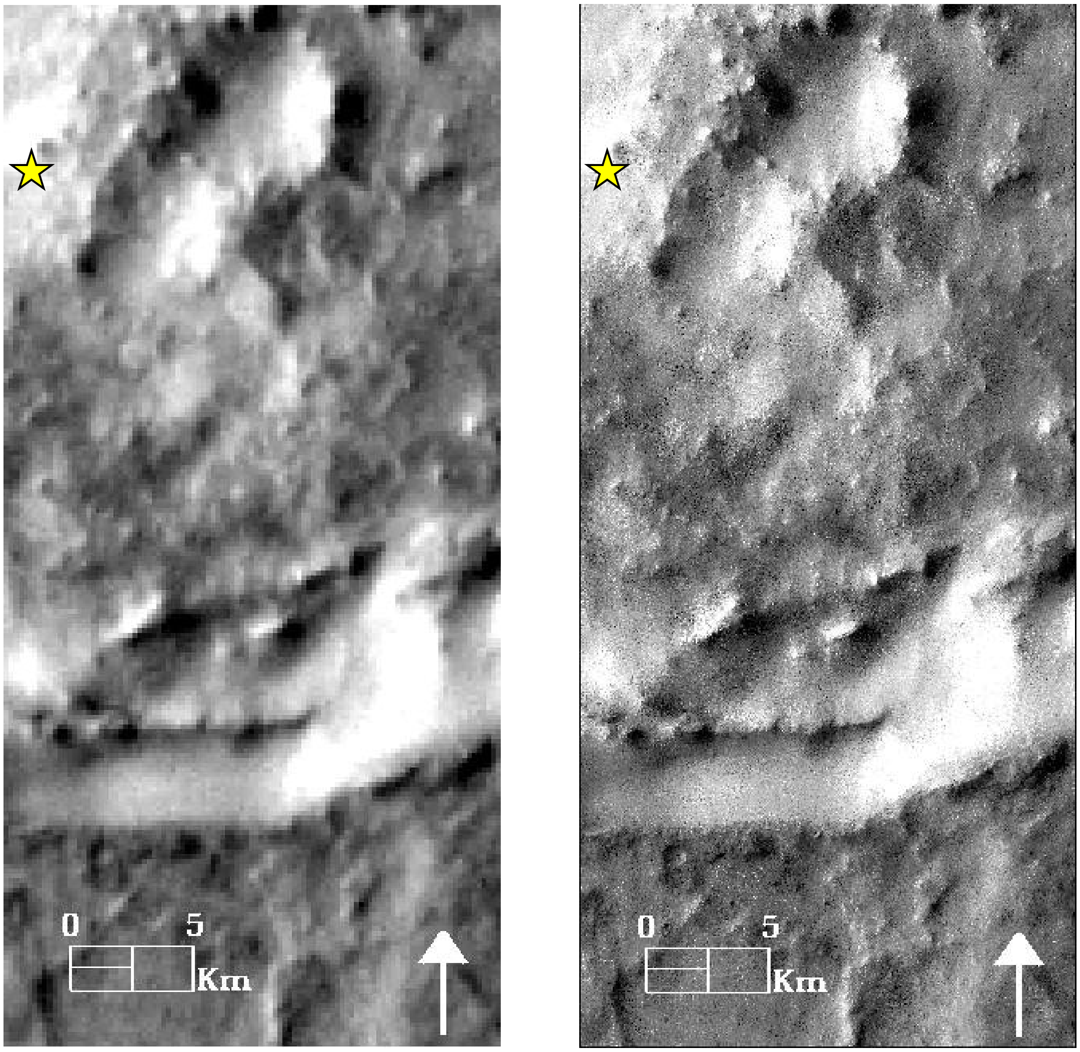

Figure 1. Super-resolution example of THEMIS TIR data [I12929010], located within the southern quartzofeldspathic-rich crater [7]. Original TIR radiance data (left) and the super-resolved result using the contemporaneous THEMIS VIS image [V12929011] (right). The star indicates the location of the spectra shown in Figure 2 below.

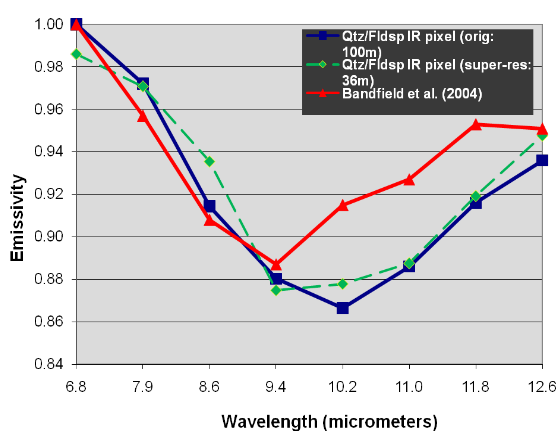

Figure 2. Spectra extracted from the colocated pixels in the original and super-resolved images compared to the spectrum of the quartzofeldspathic signature. The super-resolved pixel is one of nine 36 m resolution pixels whose spectra combine to reform the original pixel's spectrum (blue line). Note the shift of the wavelength of the band minimum from the blue to green line.