A SEARCH FOR PHYLLOSILICATES IN MAWRTH VALLIS, MARS, USING THEMIS THERMAL INFRARED MULTISPECTRAL DATA. C. E. Viviano[1], J. E. Moersch[1], and J. L. Piatek[2], [1]Department of Earth & Planetary Sciences, University of Tennessee, Knoxville, TN 37996; <cviviano@utk.edu>, [2]Physics & Earth Sciences Department, Central Connecticut State University.

Introduction: The Mars Express OMEGA has revealed mineralogically diverse, localized phyllosilicate deposits on Mars, by hyperspectral detection in the short wave infrared [1], [2]. The Mawrth Vallis region (~24°N, 340°E) is characterized by a primitive outflow channel, which once flowed south to north, crosscutting Noachian-aged [3] clay-rich plateaus. While the phyllosilicate deposits may have formed before the outflow, it is hypothesized that some of the deposits have been remobilized by fluvial flow or aeolian transport [4]. OMEGA spectra of these surfaces have revealed similarities to of lab spectra of Fe- and Mg-rich smectites and Al-rich montmorillonites e.g., [1], [4].

THEMIS, aboard the Mars Odyssey spacecraft, has acquired multispectral thermal infrared images of Mars at 100m/pixel spatial resolution. Observation of the primary silicate absorption feature in the thermal infrared may be used in conjunction with the shortwave infrared O-H related features to help constrain clay mineralogical identification [5].

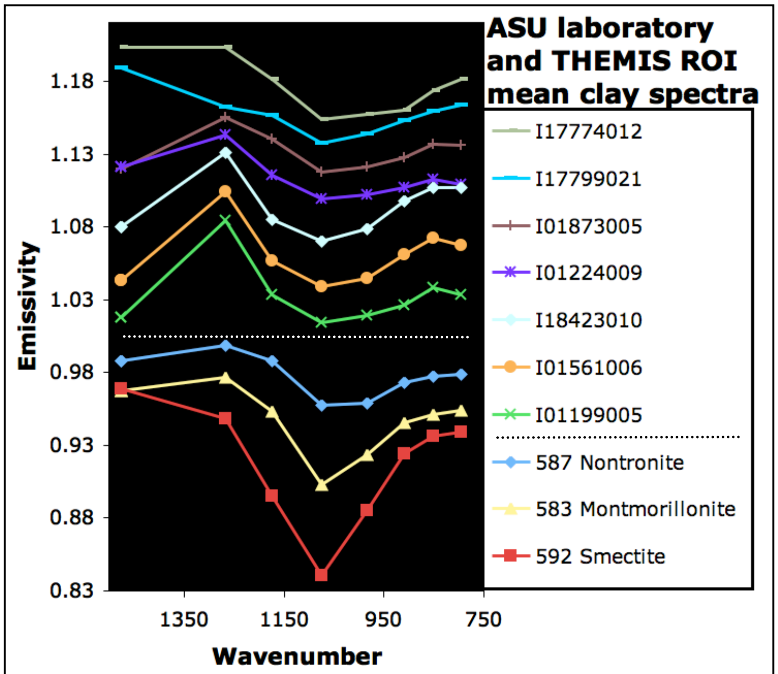

Figure 1. THEMIS image identifications represent a ROI mean spectra corresponding to OMEGA-detected clay deposits. Nontronite, montmorillonite, and smectite are laboratory spectra (ASU spectral library) resampled to THEMIS band-passes. The emissivity has been offset for clarity.

We have used THEMIS coverage of the Mawrth Vallis region, in conjunction with clay deposits detected by OMEGA, to find a clay spectral signature in the thermal infrared. Once a signature has been identified, the goal is to find an algorithm, which highlights that spectral profile and may be extrapolated to other THEMIS images.

Methods: THEMIS daytime infrared images with temperatures averaging above 240K [6] were extracted and initially corrected using a THEMIS image processing web interface (http://thmproc.mars.asu.edu). The ENVI 4.2 remote sensing software suite was used to run a custom TES-derived multiplicative atmospheric correction using techniques described in [6]. THEMIS images I01199005, I01224009, I01561006, I01873005, I17774012, I17799021, and I18423010 were processed by the methods described above. In order to identify the spectral signature for clays in the THEMIS bandpasses, thermal infrared spectra from the Arizona State University spectral library (http://speclib.asu.edu) were resampled to THEMIS bandpasses for bands 1-9. Mean spectra were extracted from regions of interest (ROIs) corresponding to the locations of OMEGA-identified phyllosilicate-rich deposits.

Results and Discussion: The THEMIS spectra extracted from areas in Mawrth Vallis where phyllosilicates have been identified in OMEGA data are similar to resampled laboratory spectra of phyllosilicates, particularly nontronite (Fig. 1). More importantly, the spectra are relatively consistent across several THEMIS images; ROIs extracted from I01199005, I01561006, and I18423010 are very similar (Fig. 1). THEMIS images I01199005, I01561006, and I18423010 have the highest daytime temperatures, and therefore have more reliable emissivity values [6]. The more variable ROI mean spectral profiles from I17774012, I17799021, I01873005, and I01224009 are likely a product of atmospheric removal iterations and/or lower daytime temperatures.

The spectral uniformity between high temperature images suggests that it may be possible to define a spectral index that is sensitive to phyllosilicates. After trial and error of many candidate indices, the following band ratio appears to provide greatest sensitivity to phyllosilicates:

$$\text{Phyllosilicate} = \frac{\text{Band 3} \bullet \text{Band 5}}{\text{Band 6} \bullet \text{Band (1,2)} \bullet \text{Band 4}}$$

The result of this procedure is shown in Figure 2 (left). Areas emphasized by the THEMIS phyllosilicate index do correlate with OMEGA-identified clay-rich regions; but the band index also appears to be sensitive to high albedo regions with no clay. A Minimum Noise Fraction (MNF) algorithm was also applied to the THEMIS emissivity images, concentrating the highest spectral variance of the image cube to the first three MNF bands (Fig. 2, right). The MNF results are useful for detecting spectral anomalies in a single THEMIS image. However, because statistics differ from one scene to the next MNF results should not be compared across scenes.

Conclusions: Our preliminary results suggest that the clay-rich regions in Mawrth Vallis detected by OMEGA also have consistent THEMIS thermal infrared spectral properties that are distinct form surrounding terrain. A THEMIS spectral index emphasizing this signature and a MNF algorithm has been used to attempt to map the clay-rich deposits. However, further work is still necessary to refine the index, so that it is sensitive to phyllosilicates independently of high albedo regions.

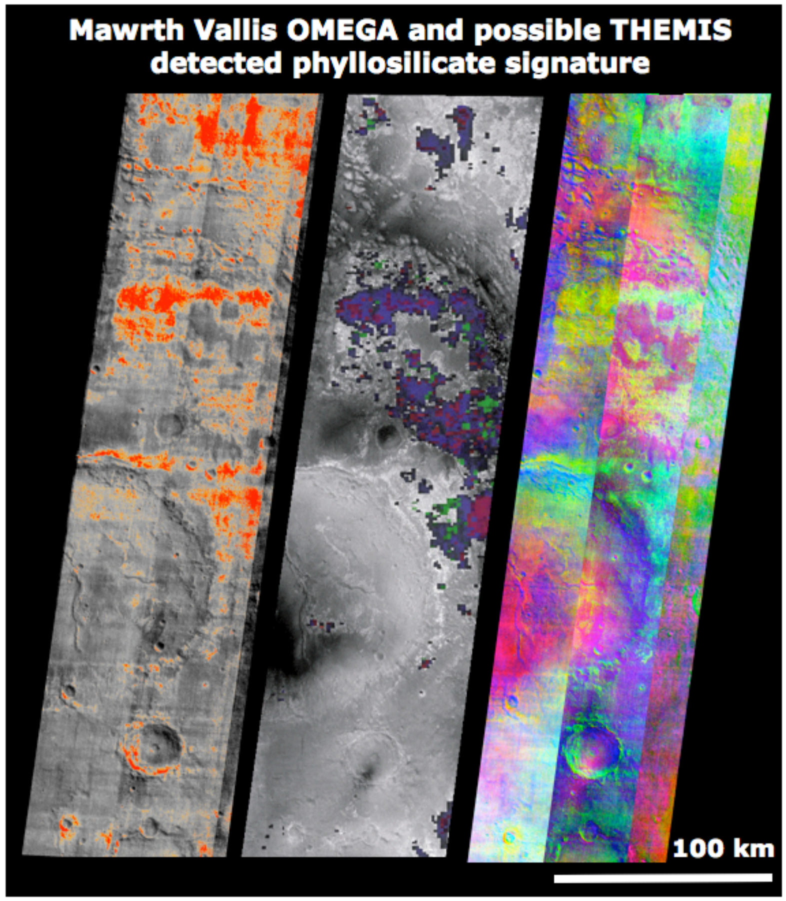

Figure 2. *Left*: Mosaic of phyllosilicate index images (see text) derived from THEMIS images I01199005, I01561006, and I18423010. Highlighted are pixels with index values range of 1.06-1.08 (orange) and 1.08-1.2733 (red). *Middle*: Subset of OMEGA-detected spectral indices of the 1.93μm, 2.20μm, and 2.3μm bands (blue, green, red, respectively) [4] for the same area as the THEMIS scene. *Right*: Mosaic of I01199005, I01561006, and I18423010 MNF results. Images are centered at approximately 24°16' N,

References: [1] Poulet F. et al. (2005) *Nature*, *438*, 623-627. [2] Bibring J. –P. et al. (2005) *Science*, *307*, 1576-1581. [3] Scott D. H. and Tanaka K. L. (1986) *U.S. Geol. Surv. Misc. Invest Ser., Map I-1802-A*. [4] Loizeau D. et al. (2007) *JGR*, *112*, E08S08. [5] Michalski, J. et al. (2005) *JGR*, *111*, E03004. [6] Banfield J. L. et al. (2004) *JGR*, *109*, E10008.