STRATIGRAPHIC RELATIONSHIPS IN THE PHYLLOSILICATE-RICH MATERIALS OF TYRRHENA TERRA, MARS. C. E. Viviano[1], J. E. Moersch[1], and J. L. Piatek[2], [1]Planetary Geosciences Institute, Department of Earth & Planetary Sciences, University of Tennessee, Knoxville, TN 37996; <cviviano@utk.edu>, [2]Department of Physics & Earth Sciences, Central Connecticut State University, New Britain, CT.

Introduction: Tyrrhena Terra, a heavily cratered, fluvially dissected section of Noachian-aged terrain is located in the southern hemisphere of Mars, south of Isidis Planitia. Hydrated minerals in the Tyrrhena Terra region on Mars were discovered by the Mars Express OMEGA experiment [1, 2, 3, 4], using a weak 1.9 μm absorption feature in spectra from this region. Commonly, phyllosilicate outcrops are identified by OMEGA in the walls and ejecta blankets of Tyrrhena Terra craters [2, 3]. About 20 ejecta blankets in this region reveal a possible presence of phyllosilicates with absorptions at both 1.93 μm (H_2O) and 2.3 μm (metal-OH) in OMEGA spectra [4]. Additionally, the Mars Reconnaissance Orbiter CRISM experiment has been used to verify these observations at a higher resolution, and has observed phyllosilicates in mounds and knobs on crater floors [5, 6, 7]. Spatially distinct phyllosilicate-rich and more mafic lithologies have also been observed along crater walls, indicating stratigraphic variations in the Noachian basement [5].

The Mars Odyssey THEMIS experiment has acquired multispectral thermal infrared images of Mars at 100m/pixel, with nearly global coverage. Because there are still gaps between scenes in the publicly available CRISM dataset, it is advantageous to use THEMIS to map phyllosilicates in areas where CRISM has no coverage. We have previously developed a THEMIS Phyllosilicate Index (TPI) that is sensitive to the same geographic regions where OMEGA and CRISM have been used to identify strong phyllosilicate signals [7]. The TPI has also been used to expand the mapping of phyllosilicates in the Terra Sirenum area, identifying new phyllosilicate-rich outcrops commonly occurring in crater floors [8]. Here we use the TPI to provide more contiguous and complete mapping of phyllosilicate exposures in part of the Tyrrhena Terra region. CRISM coverage at the <100 m/pixel level (Target Mode) is sparse, and at 200 m/pixel (Survey Mode) still has multiple gaps in this area (see Figure 1).

Methods: THEMIS daytime infrared images were processed using the THEMIS image web interface (http://thmproc.mars.asu.edu). Images with the highest average temperatures (a minimum of 240 K), and the lowest atmospheric opacities (less than 0.25), were chosen to maximize signal-to-noise ratios in the scene. The scenes were then processed to emissivity using a TES-derived multiplicative atmospheric correction [9]. The emissivity scenes were run through the TPI and following the methods of [8], detection threshold values were scaled to match CRISM detections within the scene (ranging from TPI values of 11.10 to 11.25). This diminished the effects of inter-scene variability on the overall map, and anchored the TPI threshold value to a CRISM detection.

The CRISM team's standard processing method was used on CRISM Full Resolution Targeted (FRT) images, correcting for photometric effects (diving by the cosine of the incidence angle) and atmospheric effects (diving by a scaled atmospheric transmission spectrum) using the CRISM Analysis Toolkit (CAT). The D2300 parameter was applied to each scene, sensitive to the 2.3-μm phyllosilicate absorption feature [10].

Results and Discussion: The results of the TPI mapping of the THEMIS scenes in a portion of Tyrrhena Terra are shown in Figure 1. Our results show that some areas in the CRISM Survey Mode data gaps may have significant phyllosilicate-rich material. The only CRISM FRT in this region to show a significant D2300 detection is located on the floor of the crater 'A' (Figure 1,2). The TPI detection to the immediate SE of the FRT scene indicates the phyllosilicate-bearing material extends further with a similar trend (NW-SE). The TPI appears particularly reliable here, as it represents the detection from four separate overlapping THEMIS images. Lineations are present in this visible imagery of this deposit as well as the TPI detections. Their orientation suggests that the crater 'B' has a phyllosilicate-rich ejecta blanket (Figure 2), which superposes crater 'A'. The extension of this outcrop beyond the CRISM FRT has not yet been mapped at the 100 m/pixel resolution or better. Another example of a hydrated ejecta blanket in this region is identified with the TPI at crater 'C' (Figure 3). However, in this case, the crater floor also has phyllosilicate-bearing materials according to the TPI. As previously suggested [3, 4, 5], phyllosilicate detections in the Terra Tyrrhena region appear to be associated with crater ejecta blankets. This may indicate that the phyllosilicates were excavated during the impact process from buried terrain [3, 4]. However, unlike the ~20 craters studied in [4], the ejecta blanket from these craters do not have high thermal contrast with surrounding terrain in THEMIS IR night imagery.

Finally, the application of the TPI to these scenes reveals an interesting relationship between potential phyllosilicate-rich materials and fluvial incision. Figure 4 highlights a small channel incising into the local terrain. Here, the surrounding material has elevated TPI values, suggesting erosion into the basement material exposed the phyllosilicates, but note that there is no detection within the channel itself. This could be because there is phyllosilicate-rich material in the channel that has been mantled, obscuring it spectrally. Or, perhaps more interestingly, it could be because the channel has cut below the phyllosilicate-rich layer. If the latter is true, the channel can be used to constrain the thickness of the phyllosilicate-rich layer.

Conclusions: Phyllosilicate-bearing outcrops in Tyrrhena Terra detected by CRISM and OMEGA can also be detected using the THEMIS Phyllosilicate Index (TPI). Using the TPI, we have mapped new phyllosilicate-bearing outcrops at 100 m/pixel in areas not yet covered in the publicly available CRISM dataset. The phyllosilicates in this region are commonly found to occur in impact ejecta blankets, suggesting excavation from the underlying Noachian crust. Our observations using the TPI support this hypothesis, identifying phyllosilicate-bearing ejecta blankets in at least two locations. Furthermore, we have found compelling evidence for the exposure of phyllosilicate-bearing material through channel incision. The TPI identification of new phyllosilicate deposits demonstrates the potential for a THEMIS-based identification of new exposures for future CRISM Targeting Mode observations.

References:

[1] Bibring, J.-P., et al. (2006) *Science*, *312*, 400-404. [2] Poulet, F., et al. (2006) *LPSC XXXVII*, 1698. [3] Costard, F., et al. (2006) *LPSC XXXVII*, 1288. [4] Loizeau, D., et al. (2009) *LPSC XL*, 2010. [5] Pelkey, S.M. et al. (2007) *LPSC XXXVIII*, 1994. [6] Mustard, J. et al. (2008) *Nature*, *454*, 305-309. [7] Viviano, C., et al. (2008) *Workshop on Martian Phyllosilicates: Recorders of Aqueous Processes?*, 7032. [8] Viviano, C., et al. (2009) *LPSC XL*, 2107. [9] Bandfield, J.L. et al. (2004) *JGR*, *109*, E10008. [10] Pelkey, S.M. et al. (2007) *JGR*, *112*, E00283.

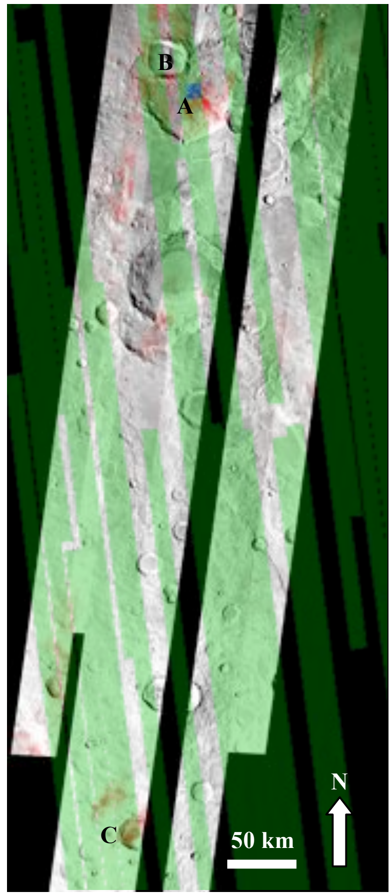

Figure 1. TPI detection in Terra Sirenum shown in red (see text for details) overlaid on THEMIS temperature data from I01844008, I08174001, I09759001, I15325001, I17122001, I17171016, I17458024, and I33668001. Transparent green indicates CRISM survey mode coverage. D2300 index shown in blue (see text for details) from CRISM scene FRT000094DA_07_IF16L. Entire image centered at ~10.16°S, 94.0°E.

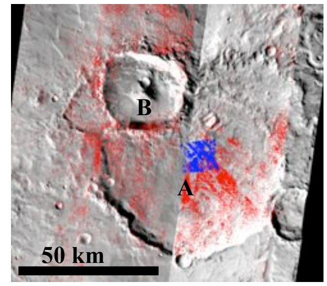

Figure 2. TPI detection in red showing phyllosilicate-rich material in crater ‘B’ ejecta blanket (extending from CRISM FRT D2300 index). D2300 index shown in blue from CRISM scene FRT000094DA_07_IF16L.

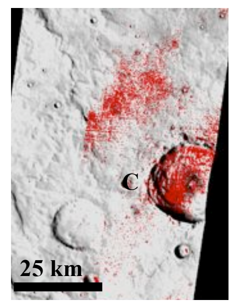

Figure 3. TPI detection in red showing phyllosilicate-rich material in crater ejecta blanket and crater floor.

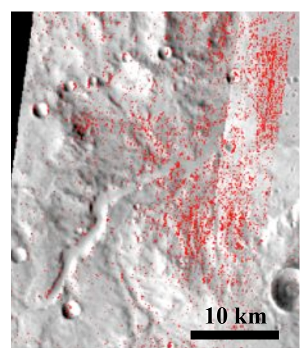

Figure 4. TPI detection in red showing phyllosilicate-rich material exposed due to channel erosion.