THERMOPHYSICAL PROPERTIES OF MANTLED VOLCANIC SURFACES AT THE MONO CRATERS, CALIFORNIA, WITH APPLICATIONS TO MARS SCIENCE.

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Introduction:

Sediment/regolith history, mobility, and its mantling of underlying bedrock are important processes to understand for Mars science. The movement of sand/dust over time significantly modifies and covers many bedrock surfaces on Mars [1]. These deposits may be derived locally and retain the chemical/spectral signatures of the underlying rocks [2-3]. However, in many cases this material is globally homogenized and obscures the surface below thereby hindering accurate identification from orbit [4-5]. Although not as pervasive on Earth, surface mantling can arise from a variety of processes such as explosive volcanic eruptions and serve as analog locations for testing both geologic and image processing hypotheses. An example of this type of terrain is the Mono Craters, an arcuate chain of silicic lava domes and coulees in California formed over the past several thousand years. Newer domes in the chain commonly cover older domes with substantial pyroclastic airfall deposits. The region contains an assortment of heavily mantled pumice surfaces and unmantled obsidian volcanic flows, commonly within meters of each other. We have hypothesized that the underlying bedrock composition of similarly mantled flows at Arsia Mons could be decoupled from that of the mantling deposits using thermal infrared (TIR) data [6-7]. Ground-truth of calibration targets allowed testing of the data retrieval methods, and their applicability to the Arsia Mons flows. Here we present the preliminary field and laboratory results of the mantled Mono Craters using a combination of TIR and visible-near infrared (VNIR) image processing, laboratory spectroscopy, and field geomorphic analysis.

Fig 1: Field site on North Coulee, Mono Craters, California. This site is about approximately a 50-50 mix of mantling pyroclastic airfall and rocky dome surface. Location on dome provided in Figure 2.

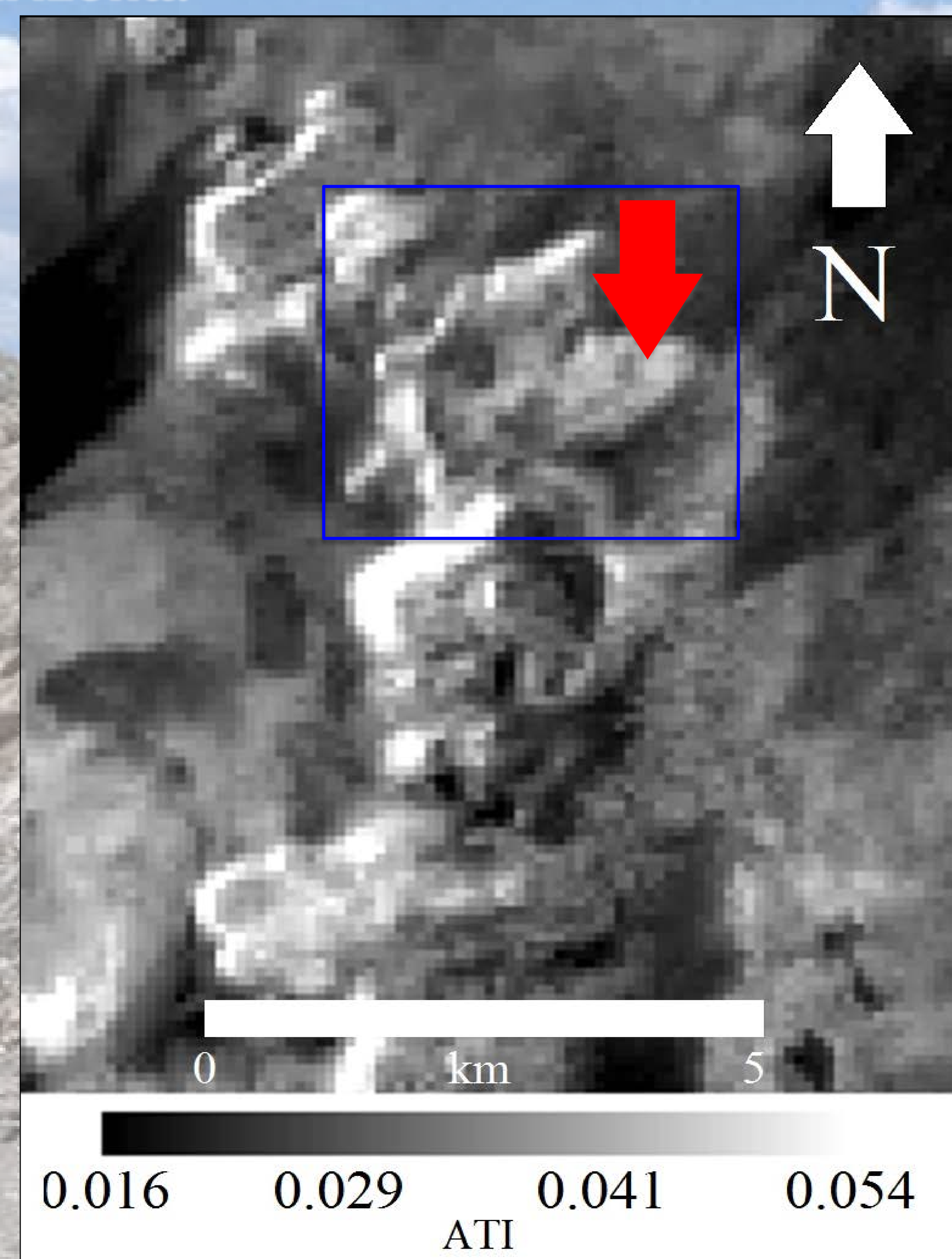

Fig 2: An ATI image created from combining ASTER images of day and night temperature differential. Red arrow: Location of image in Figure 1. Blue Box: area of density slice in Figure 3.

Methods:

Apparent thermal inertia (ATI) images for different seasons were created using ASTER data of the Mono Craters using: **ATI = (1 - a) / ΔT**, where **a** is broadband VSWIR albedo and **ΔT** is the temperature difference between a day and night pair of coregistered TIR images (Fig 2) [6]. It was hypothesized that during the arid conditions of the summer season, the ATI image would provide a proxy for the average grain size on the domes. The ATI field sites for later field-based analysis. This fieldwork was conducted over a period of a week in July 2012.

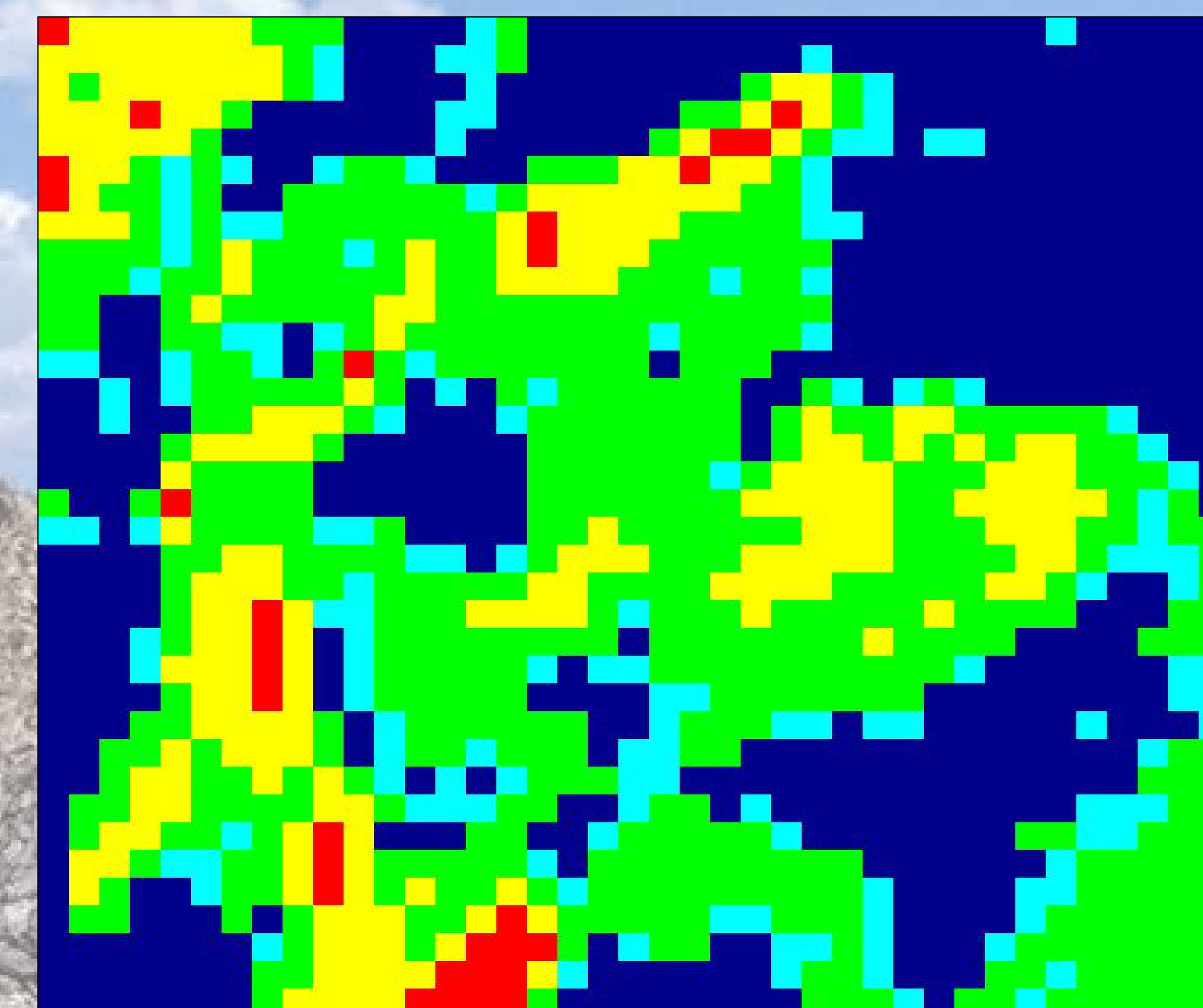

Fig 3: A density slice of an ATI map of North Coulee showcasing average grain size. Blue: < 1cm. Teal: 1cm. Green: 2cm – 0.5m. Yellow: 0.5 – 1m. Red. 1m <.

ATI:

It was determined through field observations and samples that ATI provided a credible calculation of average grain size in 90m ASTER pixels. While not infallible (due to pixel-mixing), the process provides a reliable approximation of grain size if ground-truthing is not able to be performed. A density slice of the ATI (Fig 3) is able to provide estimates of fragment size in an extremely diverse region.

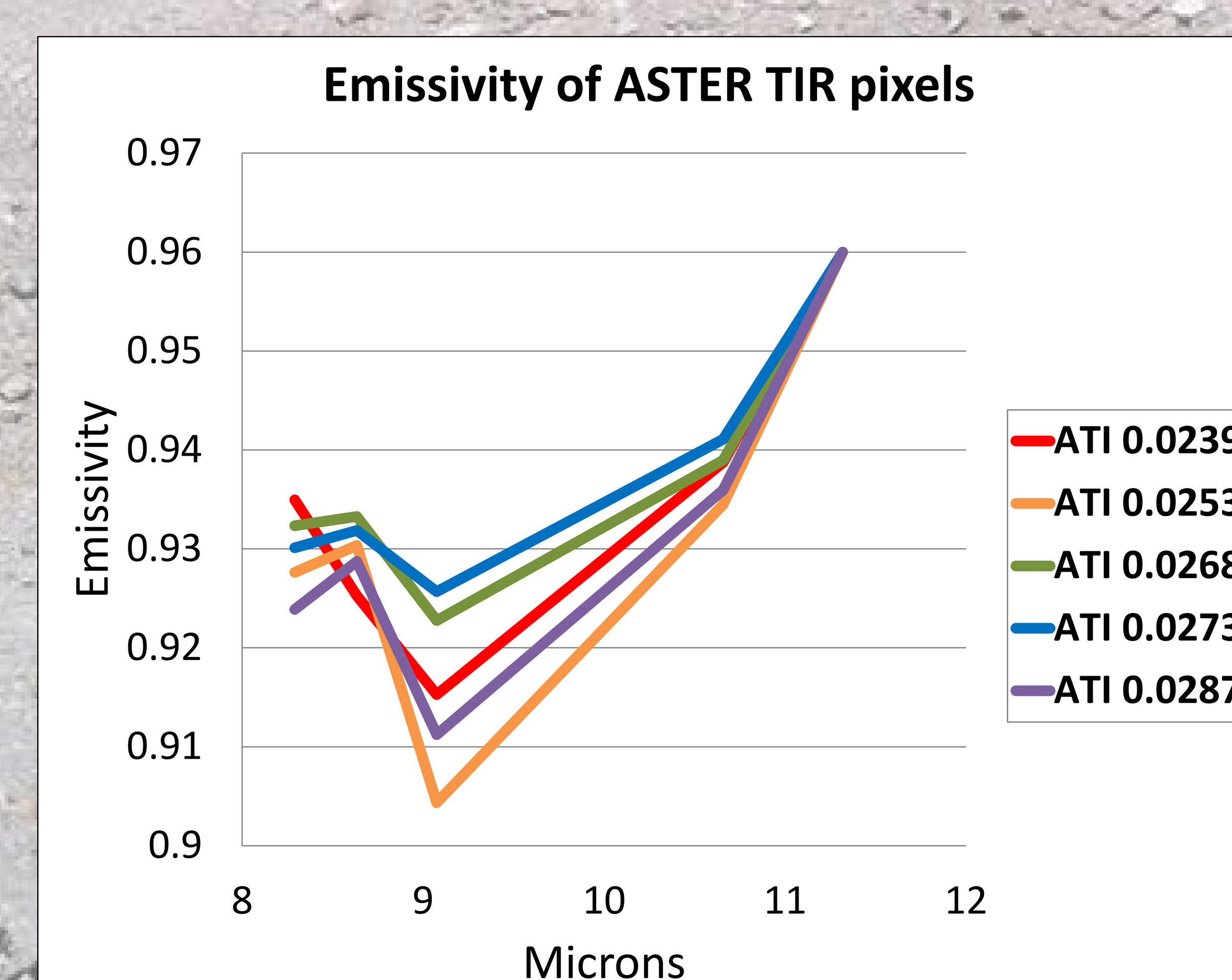

Fig 4: Plotting the emissivity of 5-point ASTER TIR spectra with their corresponding ATI values. There appears to be no visible correlation between ATI and emissivity.

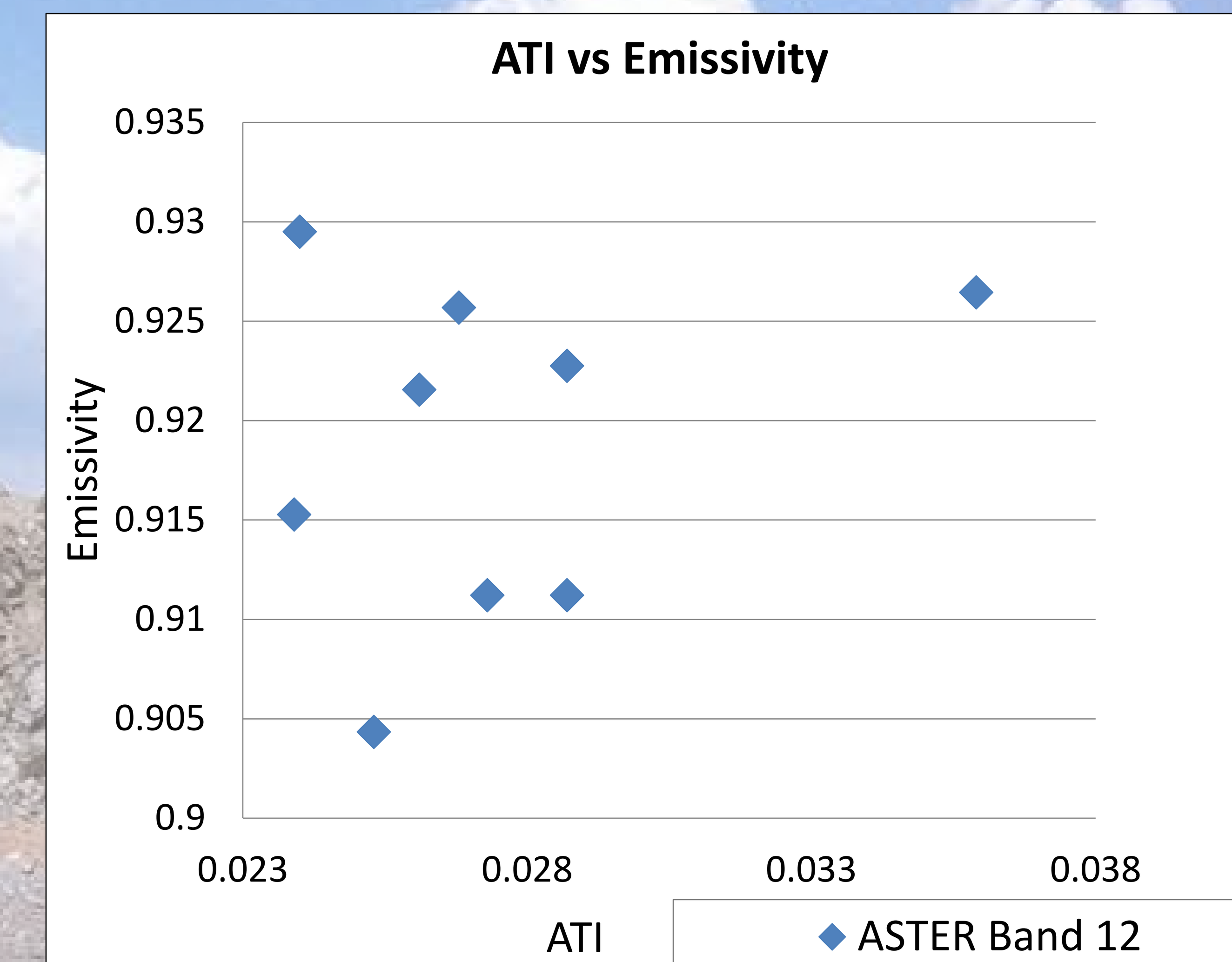

Fig 5: Emissivity of North Coulee pixels plotted against ATI using ASTER band 12 as reference.

Emissivity:

Attempts were made to correlate apparent thermal inertia values with emissivity of thermal infrared pixels of ASTER as well. Emissivity appears to be completely unrelated to the ATI of a pixel and does not show any semblance of a pattern. The silicate glass absorption feature near 9 microns also seems to have no relation to ATI. This lack of correlation can be explained by the heterogeneity and vesicularity of rocks present at the Mono Domes. The effect of vesicular rocks on emissivity proves detrimental to TIR satellite imaging of volcanic areas without ground-truthing. This can prove to be a vexing problem for Mars satellite imaging, as ground-truthing is not an option outside of Mars rover sites.

References:

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