SEARCH FOR MAFIC BEDROCK IN THARSIS AND ELYSIUM USING CRISM DATA. J. B. Plescia[1], C. Viviano-Beck[1], S. Murchie[1], F. Morgan[1], and K. Seelos[1]. [1]The Johns Hopkins University, Applied Physics Laboratory, Laurel, MD, USA.

Introduction: The Tharsis and Elysium regions of Mars are dominated by volcanic processes with shield volcanoes ranging in size from a few km to hundreds of km in diameter [1]. These shield volcanoes exhibit a range of morphologies that have varied with time. For example, in the area of Daedalia Planum southwest of Arsia Mons [2, 3], the lava flow morphology changes from broad sheet flows to narrow channelized flows as Arsia Mons is approached. Poulet et al. [4] have argued that the ratio of low calcium pyroxene (LCP) / high calcium pyroxene (HCP) has decreased over time from the Noachian into Hesperian period indicating a change in the mineralogy over time.

A fundamental question remains: Do the volcanic morphology changes observed in Tharsis and Elysium reflect changes in lava composition, eruption dynamics, or both. In order to evaluate the possible mineralogic variation of the lavas, CRISM high-resolution targeted images are used to investigate sites where bedrock spectral signatures, of these mostly dust-covered surfaces, could be obtained. Spectral data from both OMEGA and CRISM have been used to define the mafic mineralogy for a number of areas on Mars [5-9], as well as the character and distribution of alteration mineralogy [9-10].

The dust cover in Tharsis has hampered analysis of the bedrock in the past. However, the presence of dozens of recent and historic impacts [11], wherein the surficial dust has been removed, provides possible windows through which bedrock spectral signatures might be observed. In addition, areas of steep scarps may also be sufficiently dust-free to allow measurements of the bedrock reflectance spectrum. Such an approach has already been demonstrated to reveal the presence of enhanced high-calcium pyroxene at a young impact in northwest Tharsis [12].

Data Analysis: CRISM data [13-14] consist of spectra over the range 0.4-3.92 μm at 20-40 m/pixel spatial sampling. Processing of CRISM data is described in detail in [15]. We primarily examined the spectra for mafic signatures in range of 1.0-2.6 μm. To facilitate the analysis, mafic browse images [16] were used as a guide to identify locations for which more in-depth analysis would be done.

For the targets that have been studied (e.g., young impact craters and bedrock exposed on scarps), a range of grain sizes would be present - bedrock and large blocks to fine-grained material. In a few cases, the material may represent fine-grained aeolian deposits.

For each target area, individual pixels were examined to locate pixels in one of the spectral parameters indicative of mafic minerals [16]. Adjacent pixels with similar signatures were combined to remove residual atmospheric effects and to enhance signal to noise ratio. In order to accentuate the signature of the candidate mafic materials, their spectra were ratioed to adjacent spectrally neutral background in the same columns in the images as the target pixels.

The primary minerals of interest are plagioclase, pyroxenes, and olivine. Pyroxene displays broad absorption features at ~1 to 2 μm that are shifted based on composition. The 2 μm feature for HCP is centered at ~1.9 μm, whereas the feature for HCP is shifted to longer wavelength, centered at 2.3 μm. Hydrous mineral, if present, would have absorptions near 1.9 and 2.1-2.4 μm. Feldspars are typically not detectable, although some plagioclase with Fe^{2+} substitution exhibits broad absorptions at 1.25 to 1.3 μm

Results: Most of Tharsis and Elysium are covered with dust making recognition of spectral features associated with the bedrock difficult at best [17, 18]. TES data suggest that the southern flank area of Arsia Mons and portions of Alba Patera have a spectral signature indicative of both HCP and LCP [19].

Most of the CRISM targets data in Tharsis and Elysium acquired to date are featureless in the IR_mafic browse product (as well as other products) consistent with a complete surficial dust cover. Darkening of impact sites is due only to removal of a loose surficial layer. However, we have identified several areas in which spectral features indicate of bedrock composition can be recognized (Figure 1). The spectra for these areas, indicate both high-Ca pyroxene and olivine (Figure 2).

Discussion: The areas illustrated in Figure 1 represent volcanic plains in the northern and southwestern parts of Tharsis. These spectra show evidence of mafic minerals. For northern Tharsis, (CRISM 9132), a 1-μm absorption suggests the presence of olivine. For southwestern Tharsis, the two spectra are very different. CRISM 3E33 is consistent with olivine, whereas 9AEB suggest pyroxene.

While these represent only a limited number of examples, it does suggest that there is variation in the mineralogy of the lavas around Tharsis. Other spectra (not shown) in the Tharsis and Elysium region are indicative of HCP and LCP.

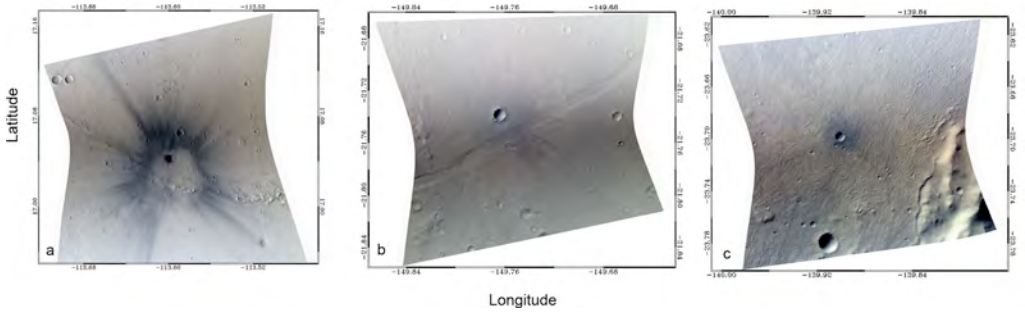

Figure 1. Visible CRISM images of selected target areas. CRISM ID noted in parentheses: a. Fresh crater in northern Tharsis (3E33) b. Fresh carter in southwest Tharsis (9132) c. Fresh carter in southwest Tharsis (9AEB).

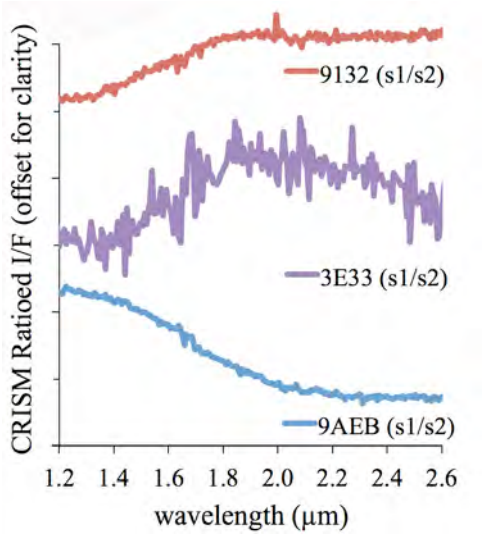

Figure 2. CRISM spectra for the areas shown in Figure 1. These spectra represent ratio of areas with mafic signatures to nearby dust covered areas.

Conclusions: CRISM IR reflectance spectra for areas in Tharsis and Elysium indicate that the mineralogy of the bedrock can be measured in selected locations. Data indicate that the mafic mineralogy varies across the region as might be expected from the morphology. Given the limited number of data points to date, it is premature at this time to attempt to correlate spectral signatures with morphology or age of the lavas. Future work will include evaluating other dust-free areas in Tharsis and Elysium.

References: [1] Carr, M. and Head, J. W. (2010) *Earth Planet. Sci. Lett.*, *294*, 185-203. [2] Crown, D. A., et al. (2013) *Lunar Planet. Sci. Conf. 44th*, Abstract 2499. [3] Garry, W. B. et al. (2013) *Lunar Planet. Sci. Conf. 44th*, Abstract 1647. [4] Poulet, F., et al. (2009) *Icarus*, *201*, 84-101. [5] Mangold, N., et al., (2010) *Earth Planet. Sci. Let.*, *294*, 440-450. [6] Mustard, J. F. (2007) *JGR*, *112*, E08S03, doi:10.1029/2006JE002834. [7] Baratoux, D. et al. (2007) *JGR*, *112*, E08S05, doi:10.1029/2207JE002890. [8] Salvatore, M. R., et al. (2010) *JGR*, *115*, E07005, doi:10.1029/2209JE003519. [9] Poulet, F., et al., (2005) *Nature, 438*, 623-627. [10] Ehlmann, B. L., et al. (2009) *JGR*, *114*, E00D08, doi:10.1029 2009JE00339. [11] Daubar, I. J., et al. (2013) *Icarus*, *225*, 506-516. [12] Morgan, M. R., and Murchie, S. (2013) *Lunar Planet. Sci. Conf. 44th*, Abstract 2803. [13] Murchie, S. L., et al. (2007) *JGR*, *112*, doi:10.1029/2006JE002682. [14] Murchie, S. L. et al. (2009) *JGR*, 114, E00D06, doi:10.1029/2009JE003342. [15] Seelos, F., et al. (2014) *Lunar Planet. Sci. Conf. 44th*, Abstract 2563. [16] Pelkey, S. M., et al. (2007) *JGR*, *112*, E08S14, doi:10.1029/2006JE002831. [17] Hamilton, V. E., et al., 2003, *Met. Planet. Sci.*, *38*, 871-886. [18] Ruff, S. W. and Christensen, P. R. (2002) *JGR*, *107*, doi:10.1029/2001JE001580. [19] Bandfield, J. L., *JGR*, *107*, E65042, 10.1029/2001JE001510.