

MRO/CRISM OBSERVATIONS OF INTERIOR LAYERED DEPOSITS OF TITHONIUM CHASMA, MARS. Scott L. Murchie¹, Jeffrey R. Johnson¹, and Frank P. Seelos¹, ¹Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, scott.murchie@jhuapl.edu.

Overview: The interior layered deposits (ILDs) of Valles Marineris occur throughout the chasma system, locally forming deposits 5 km or greater in thickness [1]. Orbital remote sensing by the OMEGA visible/infrared spectrometer on Mars Express revealed widespread occurrence of monohydrated and polyhydrated sulfate minerals within the ILDs, and close spatial association of sulfates with crystalline iron oxides [2,3]. This mineral assemblage is interpreted to indicate an acid, saline depositional environment [4]. Subsequent higher resolution observations from the CRISM spectrometer on the Mars Reconnaissance Orbiter have revealed complex stratigraphic relations between beds containing different iron and sulfate minerals. In Juventae [5] and western Candor Chasma [6] and in Aram Chaos [7], polyhydrated sulfate-bearing material is stratigraphically above monohydrate-bearing material; locally, both are underlain by anhydrous ferric hydroxysulfate-bearing material [7]. In eastern Candor [8] and Melas Chasma [9] stratigraphy is more complicated and layers having different sulfate mineralogies are interbedded. It has been proposed that the ILDs formed where discharge of sulfate-bearing groundwater trapped eolian sediment [6,7,10] and that mineralogy was controlled by chemistry of the depositional environment [6,8].

Here we report first results from analysis of CRISM data covering western Tithonium Chasma, including a far-western outlier of the ILDs whose location tests proposed genetic mechanisms and regional relations. Tithonium ILDs are draped over remnants of eroded highland crust, and exhibit less lateral continuity than typical in other chasmata. ILDs in eastern Tithonium have been interpreted as disrupted by faulting and flow [11]. This discontinuity also challenges interpretation of CRISM data taken under differing illumination and atmospheric conditions, which introduce inter-scene differences in spectral properties.

Data and Methods. Figure 1A shows image footprints from observations that cover the Tithonium ILDs and their surroundings, including hyperspectral (FRT) observations (544 wavelengths, 18 m/pixel) and half resolution (HRL) observations (36 m/pixel) and multispectral survey strips (200 m/pixel, 72 wavelengths). All of the data were processed using the latest version of the radiometric calibration ("TRR3") [12], corrections for atmospheric gas absorptions using a modified version of the "volcano scan" correction with reduced artifacts near 2.07 μm [13], fitting of I/F as a function of phase and emission angles to normalize atmospheric opacity to that at a near-nadir viewing geometry, and division by cosine of solar

incidence angle to approximate Lambert albedo [12].

Spectral Results. Figures 1B through 1D illustrate spatial distributions of different mineral groups shown by their absorption features to be present. Figure 2 shows spectra of type occurrences of different materials. Typically the ILDs are elevated in albedo with absorptions near 2.11 and 2.40 μm indicating the presence of monohydrated sulfate minerals. In the same materials there is a steep visible-wavelength spectral slope, and the weak $\sim 1\text{-}\mu\text{m}$ band typical of "dust" is shifted to shorter wavelengths due to an absorption near 0.9 μm characteristic of crystalline ferric oxide. Locally the signature of monohydrated sulfate is replaced by a band near 1.93 μm and a downward inflection in the spectrum at $>2.3\ \mu\text{m}$, indicating one or more polyhydrated sulfates. In some locations in addition to the 1.93- μm band there are weak absorptions at 2.21, 2.27, 2.40, and 2.47 μm consistent with a component of jarosite. The ILDs are surrounded and partially draped by sand deposits having spectral signatures typical of highland mafic rocks with shallow 1- and 2- μm pyroxene absorptions.

Stratigraphic Relations. Stratigraphy of the Tithonium ILDs is complex. Locally the polyhydrated sulfate-bearing material is interbedded with monohydrate-bearing material; elsewhere it and/or jarosite occupy topographic lows in eroded ILDs or basement. In other locations the planform of domains having different mineralogy suggests faulting and ductile flow. A mosaic of CRISM observations covering these ILDs is being assembled and will be draped over terrain models to better understand these relations.

References: [1] Lucchitta, B. et al. (1992) in *Mars*, H. Kieffer et al. (Eds.), Univ. of Ariz., Tucson. [2] Gendrin, A. et al. (2005a) *Science*, 307, 1587-1591. [3] Gendrin, A. et al. (2005b) *LPSC 36*, abstract #1378. [4] Bibring, J.-P. et al. (2007) *Science*, 317, 1206-1210. [5] Bishop, J. et al. (2009) *J. Geophys. Res.*, 114, doi:10.1029/2009JE003352. [6] Murchie, S. et al. (2009) *J. Geophys. Res.*, 114, doi:10.1029/2009JE003343, 2009. [7] Lichtenberg, K., et al. (2010) *J. Geophys. Res.*, 115, doi:10.1029/2009JE003353. [8] Roach, L. et al. (2009) *J. Geophys. Res.*, 114, doi:10.1029/2008JE003245. [9] Liu, Y. et al. (2012) this volume. [10] Andrews-Hanna, J. and K. Lewis (2011) *J. Geophys. Res.*, 116, doi:10.1029/2010JE003709. [11] Forese, C. and D. Baioni (2010) *Planet. Space Sci.*, 58, 1500-1505. [12] Seelos, F. et al. (2011) *LPSC 42*, abstract #1438. [13] Morgan, F. et al. (2011) *LPSC 42*, abstract #2456.

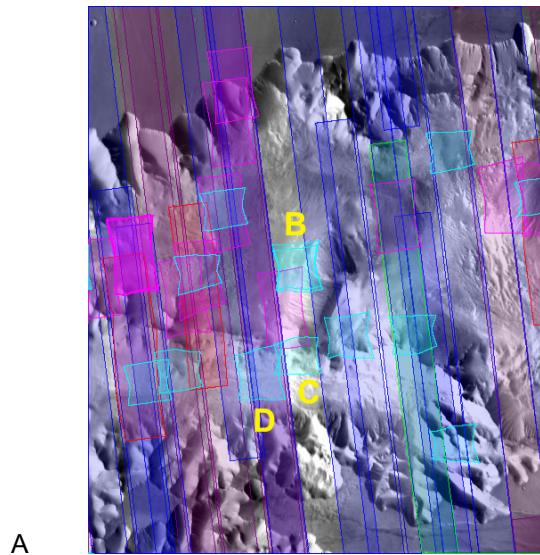


Figure 1. (A) Location map showing footprints of CRISM mapping and targeted observations in western Tithonium Chasma, and the footprints of observations shown in 1B, 1C, and 1D. (B through D) False color composites of full-resolution observation IDs 3EEF, 510D, and 97B1. At top are RGB false-color composites created from corrected I/F at 2.53, 1.33, and 0.77 μm ; at bottom are RGB combinations of summary parameters SINDEX, BD2100, and BD2290. In the bottom views, areas with spectra typical of mafic materials having pyroxene absorptions are blue to blue-green. Materials with spectra consistent with monhydrated sulfates are green to yellow-green, and polyhydrated sulfates and jarosite red to magenta.

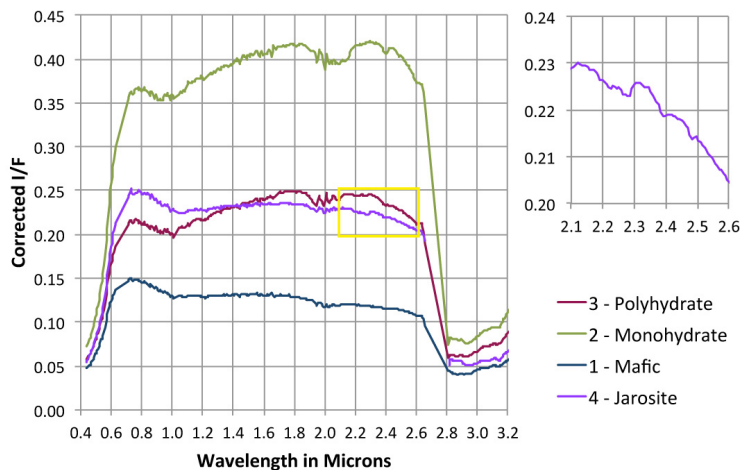
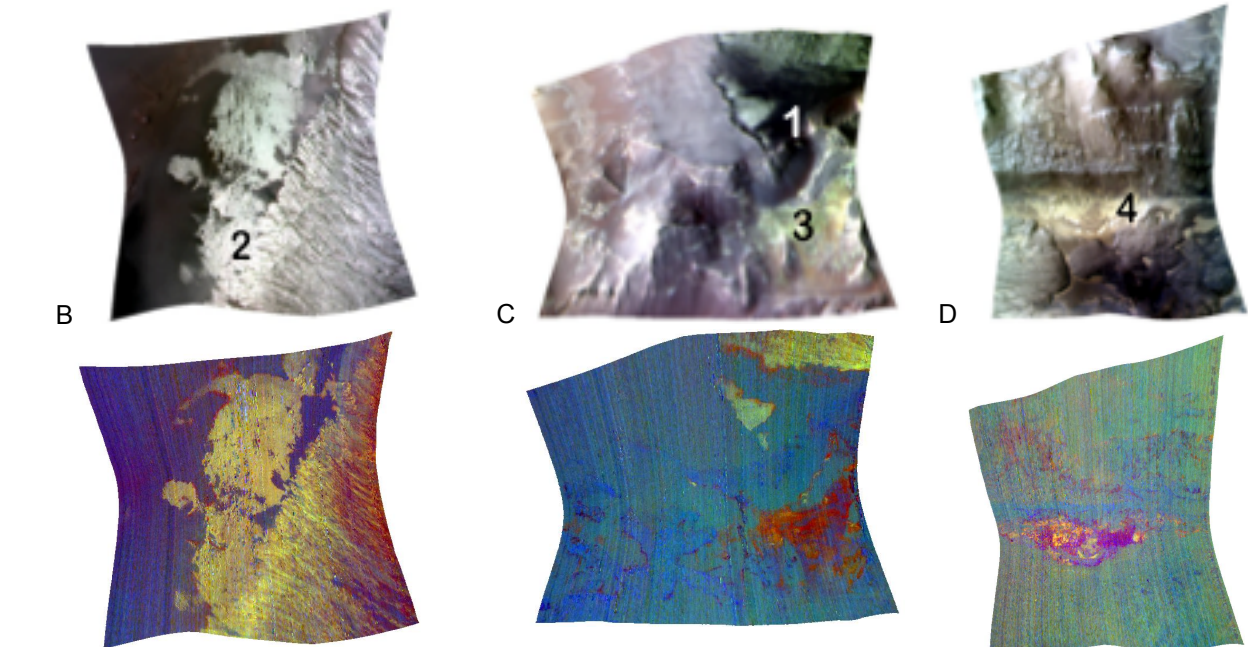


Fig. 2. Lambert albedo spectra showing type examples of absorptions. 1- mafic material (broad features near 1 and 2 μm due to pyroxene); 2 - monohydrated sulfate (near 2.11 and 2.40 μm); 3 - polyhydrated sulfate (near 1.93 μm with a falloff longward of 2.3 μm); 4 - jarosite (weak features near 2.21, 2.27, 2.40, 2.47 μm).