SURFACE MINERALOGIC MAPPING IN CENTRAL VALLES MARINERIS USING CRISM MULTISPECTRAL MAPPING DATA.

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Introduction: Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [1] visible-near infrared hyperspectral data are used to understand the types and distributions of minerals on Mars' surface. CRISM targeted images (~20 m/pix) paired with High Resolution Imaging Science Experiment (HiRISE) [2] and Context Camera (CTX) [3] imaging have previously revealed layered deposits on the floor of Valles Marineris that are dominated by hydrated sulfate minerals [e.g., 4, 5]. To build upon these detailed analyses, we used the lower spatial resolution, but extended coverage of the CRISM multispectral mapping data (~200 m/pix) to investigate of the floor of central Valles Marineris and better understand the extent of the sulfate-bearing layered deposits.

Methods: CRISM mapping-mode data from the IR detector (~1-4 µm) were first processed through standard photometric and atmospheric corrections, a noise mitigation step, and then mosaicked into 5 by 5 degree tiles. Three of these tiles were then rendered into three-color (red-green-blue) spectral parameter [6] composites of the study region (Figure 1) that focused on hydrated mineralogy in the study region (e.g., R: SINDEX2, G: BD2100_2, B: BD1900_2). CRISM composites were used in conjunction with Thermal Emission Imaging System (THEMIS) daytime and nighttime IR global mosaics [7] in JMARS in order to determine and delineate the most likely occurrences of hydrated sulfates. Regions of interest (ROI) were identified and spectral data extracted for comparison and verification using IDL/ENVI. ROI spectra were ratioed to that of a nearby surface in the same image strip that did not display any diagnostic spectral signatures. Ratioed spectral data were then compared to a reference taken from the MICA library [6] for validation (Figure 2, 3). The distribution of confirmed mineral exposures were examined using data from THEMIS and contacts for these mapped exposures were refined to better align with surface morphology, in particular where interpolation was needed across gaps in the CRISM data. These final mineralogic units were then compared to the mapped geologic units from Tanaka et al. [8].

Results: Both mono- and polyhydrated sulfates are distributed across the valley floor (Figure 1) and were nearly all located in Hesperian and Amazonian-aged geologic units as mapped by [8], with ~85% occurring within the Hesperian transitional undivided unit (Figure 4). The remaining mapped units were found on bordering geologic units that could have formed in the Hesperian or Amazonian. This composition and timing of these units reflect the acidic and less water-rich conditions in these time periods that were conducive for the formation of sulfates [9].

Summary and Future Work: Although previous research has established the presence of hydrated sulfates on the floor of central Valles Marineris using CRISM targeted data, our analysis expands and confirms the broad extent of this mineralogy. Moreover, this reaffirms the idea that a regional scale formational and/or modification processes took place during the Hesperian.

We can further this work by incorporating visible (0.4-1 µm) CRISM data in order to examine the broad spatial distribution of hematite and other iron oxides known to be associated with the hydrated sulfates [e.g., 9]. In addition, more detailed examination of high resolution datasets, such as CTX, may provide specificity regarding any widespread trends in type of hydrated sulfate and characteristic morphology.

References: [1] Murchie, S. L. et al. (2007), JGR, 112, E05, S03. [2] McEwen, A. S. et al. (2007), JGR, 112, E05. [3] Malin, M. C. et al. (2007), JGR, 112, E05. [4] Roach, L. H. et al. (2010), Icarus, 207(2), 659-674. [5] Gendrin, A. et al. (2005), Science, 307. [6] Viviano-Beck, C. E. et al (2014), JGR, 119 [7] Edwards, C. S. et al. (2011), JGR, 116., 1403-1431. [8] Tanaka, K. L. et al. (2014). [9] Murchie, S. L. et al. (2009), JGR, 1991-2009.
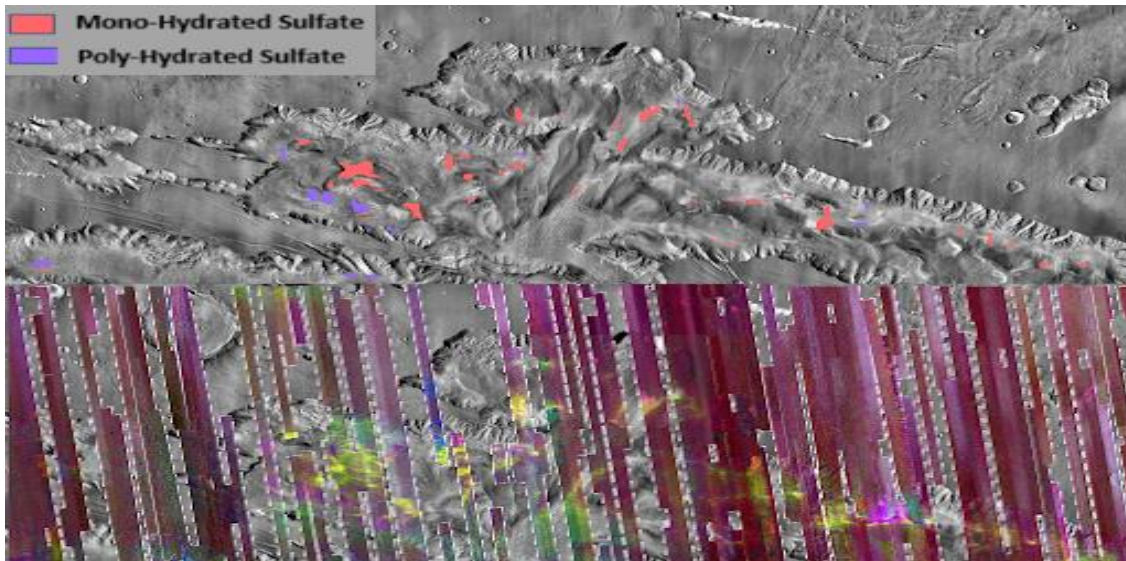
Figure 1: Central Valles Marineris study region showing (top) THEMIS with final mapped hydrated sulfate units and (bottom) mosaic of three CRISM map tiles with summary parameter composite highlighting hydrated sulfate mineralogy (R: SINDEX2, G: BD2100_2, B: BD1900_2); yellow tones indicate monohydrated sulfate and bright purple tones indicate polyhydrated sulfates.
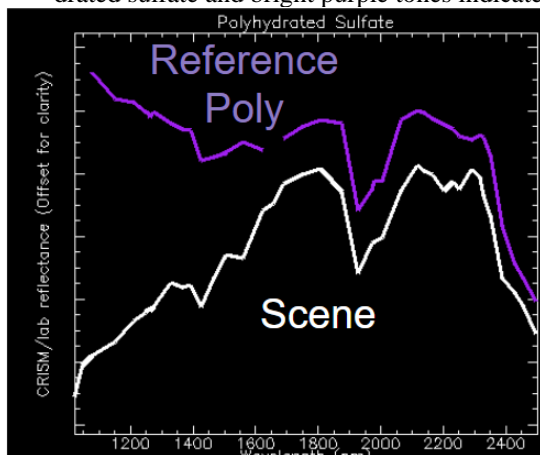

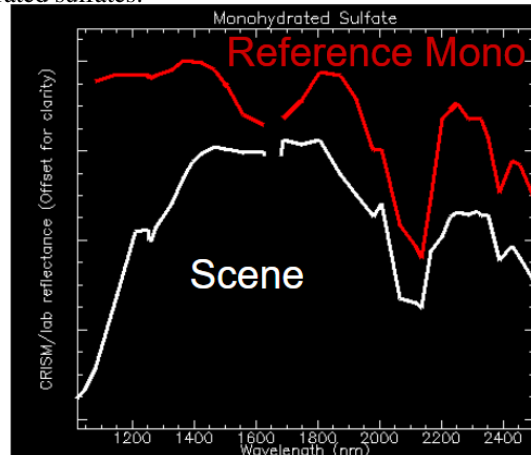**Figure 2:** Spectral data comparison between MICA library and mapped polyhydrated sulfate.

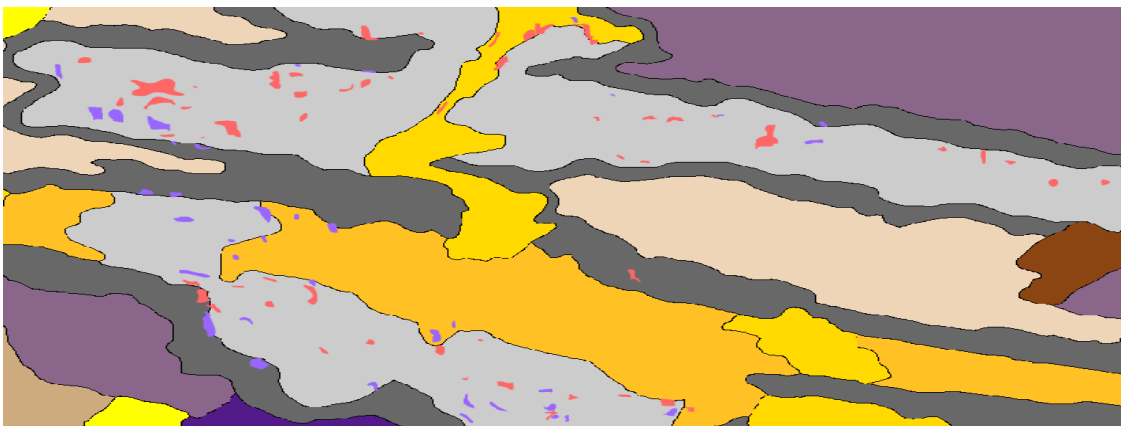**Figure 3:** Spectral data comparison between MICA library and mapped monohydrated sulfate.

Figure 4: Mapped mineralogic units overlayed on Tanaka et. al. map for geologic time units.