SPECTRAL MAPPING USING CRISM DATA IN THE NORTHWEST NOACHIS TERRA REGION.
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Introduction: Launched in 2005, the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [1] is an instrument that measures the composition of Mars's surface and allows scientists to understand climate patterns that relate to the presence of water on the planet. Our effort consisted of assisting in ongoing mapping by validating and compositionally mapping using CRISM images in three unique areas: Northwest Noachis Terra (this work), Terra Sabaea, and Central Valles Marineris. Spectral analysis utilizing image analysis software of each regions of interest were compared with reference spectra in the MICA library [2], a compilation of the best CRISM end member mineral detections, in order to identify and label minerals in the regions of interest.

Compositionally, the NW Noachis Terra region revealed large amounts of low calcium and high calcium pyroxene (LCP and HCP, respectively), magnesium smectite, and iron smectite. This concentration of minerals suggests an aqueous past, as smectite phyllosilicates generally form as a result of aqueous alteration.

Methodology: CRISM can detect visible and infrared wavelengths ranging from 0.4 - 4 microns [1] and is sensitive to absorption features due to primary and secondary minerals. For this project we utilize CRISM "tiles", 5 by 5 degree mosaics of ~200-m/pixel mapping-mode data (Fig. 1 upper). Absorption bands from mineral signatures are parametrized and derived Red-Green-Blue false color composites of these parameters are used to highlight where detectable minerals are present (Fig. 1 lower). A variety of programs were utilized in order to compare these parameter composites to observable surface features. Java Mission-planning and Analysis for Remote Sensing (JMARS) [3], a geospatial information system (GIS), was used to pinpoint areas of interest in the provided tiles by observing different RGB parameter composites. Once areas of interest were pinpointed, the Environment for Visualizing Images (ENVI) [4], a geospatial imaging program, was used to ratio spectra from these areas against other more spectrally-bland regions along the same image strip in the mosaic. These ratios were then plotted with the reference spectra of potential mineral matches from the MICA library for comparison (Fig. 2). By plotting these ratios, the spectrally-dominant component of each area of interest was able to be classified. The location of these mineral outcrops were then compared to the USGS Geologic Map of Mars (Fig. 3) [5], to determine the age of the units the materials formed in. Five tiles were analyzed in NW Noachis Terra (Fig. 1).

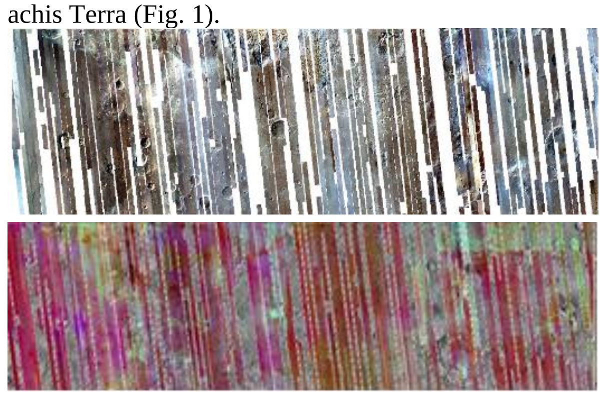

Figure 1: Mosaic of five tiles of CRISM mapping data covering NW Noachis Terra study region (top). False color mosaic (bottom). CRISM mafic parameter composite. Teal/green = LCP, magenta = HCP.

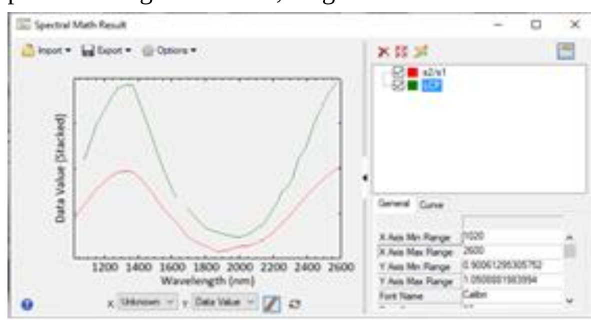

Figure 2. Example ratioed data (red) plotted against a library LCP spectrum (green).

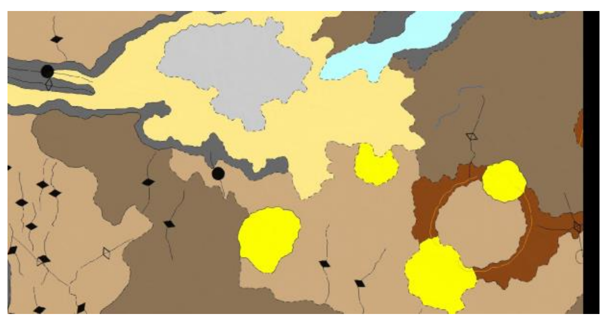

Figure 3. Geologic map of NW Noachis Terra [5]. Yellow represents Amazonian and Hesperian impact material; dark brown represents middle Noachian highland material; light brown/beige represents late Noachian highland material; light yellow represents Hesperian transition material; rusty brown represents early Noachian highland material.

Results: Phyllosilicates have been previously identified in targeted CRISM images of NW Noachis Terra [e.g. 6, 7, 8]. Our observations of mapping-mode data confirmed these results, as iron and magnesium smectite were identified in multiple locations throughout the region. In addition, high concentrations of LCP and HCP were also identified. By comparing these identifications with the geologic map of the region (Fig. 3), a few key observations were able to be made.

Mapped minerals were primarily identified in geologic units of Noachian age. The majority of LCP in the region is of early and middle Noachian age while the majority of mapped HCP was from the late Noachian period. Phyllosilicates were found in both middle and late Noachian aged units, petering off by the Hesperian period. Some LCP was identified in Hesperian aged units, making these the youngest mineral detections in the region. Further examination of the area may provide more information on this relatively young LCP and its implications for the region.

We compared these mineral observations to the geomorphology of the region, as shown in Thermal Emission Imaging System (THEMIS) [9] images, to attempt to determine potential formation processes. Figure 5 shows our in-progress mineralogic map. LCP was most commonly found in or around impact craters, while HCP was generally not associated with craters. Phyllosilicates also tended to be either in close proximity to or within craters.

While previous work has attributed much of the phyllosilicate formation in NW Noachis Terra to pedogenesis [e.g. 6], possibly with involvement of groundwater flow [e.g. 7], the tendency towards phyllosilicates associated with craters may indicate "impact-induced alteration" [e.g. 8] occurred in this region. Further work needs to be done, but preliminary results from this project confirms a strong tendency for phyllosilicate formation in NW Noachis Terra in the CRISM mapping-mode data, thus confirming aqueous activity in its past.

Acknowledgments: This project was funded by grant #80NSSC17K0451 through the NASA Mars Data Analysis Program, and by the CRISM investigation on the Mars Reconnaissance Orbiter through Jet Propulsion Laboratory (JPL) subcontract 1277793 to the Johns Hopkins Applied Physics Laboratory (APL). This project was made possible through the CIRCUIT program at APL, which offers undergraduate students an opportunity to participate in cutting-edge research while building skills to make significant contributions to science. I would like to thank Will Gray-Roncal and Martha Cervantes from CIRCUIT for giving me this amazing opportunity. I would also like to thank my research team, Adriana Peña [10] and Ryan O'Connor [11], for their contributions towards this project and their extensive support in making this presentation possible. Additionally, I would like to thank Frank Seelos, Scott Murchie, and Kirby Runyon at APL) for their support and lessons.

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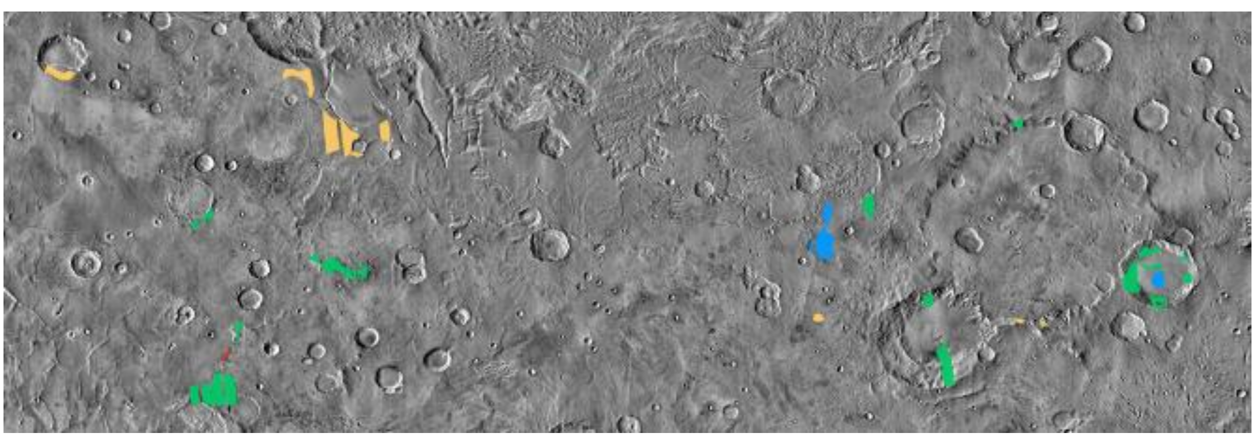

Figure 4. THEMIS image mosaic of the NW Noachis Terra study region, superposed with mineralogic units mapped on CRISM maping mode-tiles. Green represents LCP, blue represents HCP, and beige represents phyllosilicates.