CHARACTERIZATION OF LIGHT-TONED SULFATE AND HYDRATED SILICA LAYERS AT JUVENTAE CHASMA USING CRISM, OMEGA, HIRISE AND CONTEXT IMAGES.
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Introduction: Juventae Chasma northeast of Valles Marineris contains several sulfate-rich mounds inside the chasma and hydrated silica/phyllosilicate deposits on the western flanks of the chasma. We are investigating the morphologies of the regions that exhibit the strongest mineral signatures in Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) images. The light-toned layered mounds exhibit monohydrated sulfate signatures most consistent with keiserite, plus some polyhydrated sulfates. Coordinated analyses of High Resolution Imaging Science Experiment (HiRISE) and Context Camera (CTX) images show that the light-toned layered deposits on the plains have a distinct lithology from those within the chasmata, indicating that these likely formed via separate processes.

Image background: Targeted MRO/CRISM images collect 544 wavelengths from 0.36 to 3.9 µm in ~10-12 km wide swaths at 18-36 m/pixel resolution, while survey mode images collect 72 wavelengths at 100-200 m/pixel resolution [1]. Images are processed for instrumental effects, converted to I/F and the atmosphere is removed using a ratio with a CRISM scene of Olympus Mons, scaled to the same column density of CO_2 as in [2, 3]. Ratios to spectrally unremarkable regions in the scene are used to resolve spectral features. Spectra were extracted from 5X5 or 10X10 pixel regions or larger region of interest (ROI) spaces when possible.

HiRISE images are collected with a spatial resolution as low as ~25 cm/pixel [4] and are acquired in a coordinated manner with CRISM observations.

Introduction: Catling et al. [5] favor lacustrine or airfall deposition for the formation of the light-toned layered outcrops in Juventae Chasma that they have labeled Mounds A, B, C and D. Gendrin et al. [6] used spectra from the Observatoire pour la Minéralogie, L'Eau, les Glaces et l'Activité (OMEGA) instrument to identify gypsum ($CaSO_4 \cdot 2H_2O$) in the interior region of Juventae Chasma, primarily in Mounds A and B, using bands near 1.45, 1.77, 1.92, and a spectral dropoff at 2.4 µm. Similarly, they used bands near 1.6, 2.1 and 2.4 µm to identify monohydrated sulfate that best corresponded to the mineral kieserite ($MgSO_4 \cdot H_2O$). Analysis of CRISM images [7] has shown the presence of kieserite and perhaps szomolnokite ($Fe^{2+}SO_4 \cdot H_2O$) in these bright-toned mounds as well as polyhydrated sulfate that may be gypsum or starkeyite ($MgSO_4 \cdot 4H_2O$). Starkeyite exhibits strong spectral features due to H_2O near 1.44 and 1.94 µm, plus a doublet due to SO_4 and/or H_2O at 2.42 and 2.52 µm. Olivine and pyroxene have been found in small outcrops near the mounds and are thought to be components of the mafic mantling material in this region.

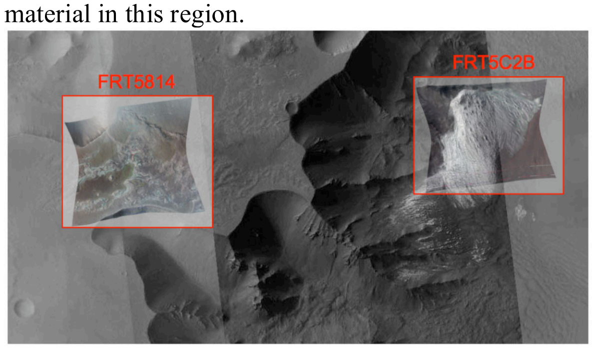

Fig. 1 CTX image mosaic of the western region of Juventae Chasma with CRISM images FRT00005814 (hydrated silica deposit) and FRT00005C2B (sulfate-rich Mound A) overlain.

Results: Analysis of CRISM images suggests that sulfate minerals are present in the chasma walls and mounds and that they are partially covered by dust, spectrally unremarkable mantling material or dunes. CRISM specra and images of Mound A are shown in Fig. 2. The spectral features are most consistent with the monohydrated sulfate mineral kieserite. There is some evidence of polyhydrated sulfate minerals such as gypsum or starkeyite in the other sulfate mounds (not shown). HiRISE images illustrate the fine, layered texture of the sulfate outcrops and show bright blocky sulfate-bearing material mixed with darker components (e.g. Fig. 2C). The layers in Mound A appear to be consistent with repetitive sedimentary deposition.

The light-toned layered deposits west of the chasmata (Fig. 3) have a distinct mineralogy and lithology from those within the chasmata, indicating that these deposits likely formed by different processes. These light-toned layered deposits occur in inverted channels on the plains, instead of on blocky mounds as inside the chasmata. They exhibit spectral features consistent with hydrated silica and phyllosilicate precursors rather than sulfates. The CRISM spectrum shown in Fig. 3 is similar to amorphous Al/Si-OH phases observed in a solfataric site at Kilauea, HI [8], and a hot spring sinter from Yellowstone National Park [9]. The light-toned deposits also exhibit color variations and differences in friability.

The presence of monohydrated sulfates, polyhydrated sulfates, and hydrated silica, and the associated outflow channel in Juventae Chasma implies complex aqueous activity. Possible processes under consideration include a combination of a sedimentary origin for the sulfate-bearing mounds and a separate fluvial leaching and alteration event for the hydrated silica deposit. Hydrothermal activity in the region may be able to explain both kinds of light-toned layered deposits.

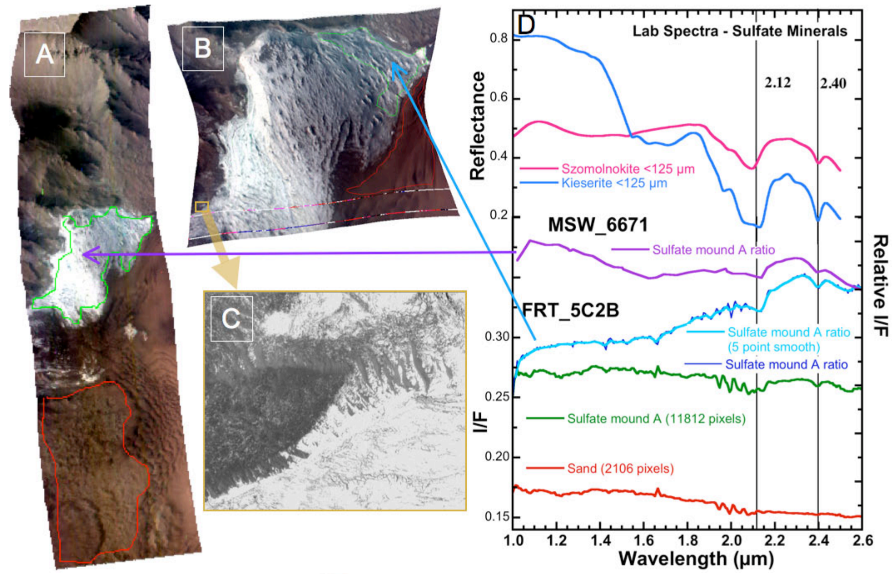

Fig. 2 Light-toned layered outcrops in Mound A: A) CRISM MSW00006671 image showing sulfate (green outline) and background (red outline) ROI areas, B) CRISM FRT00005C2B image showing sulfate (green outline) and background (red outline) ROI areas, C) portion of HiRISE image PSP_005557_1755, D) ratio spectra of the kieserite-rich layered outcrop from MSW6671 and FRT5C2C, ROI spectra of the kieserite-rich and background areas, and lab spectra of monohydrated sulfate minerals.

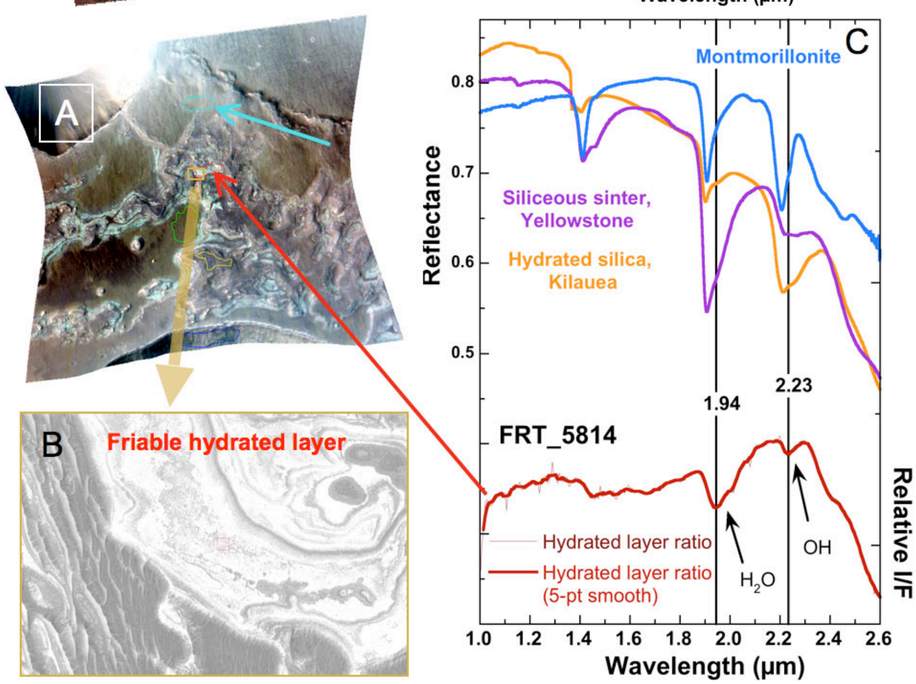

Fig. 3 Light-toned layered deposits on the plains west of Juventae Chasma: A) False color IR CRISM FRT00005814 image (R2.5, G1.5, B1.1 μm) showing hydrated materials in light blue, B) portion of HiRISE image PSP_003434_1755 showing bright hydrated layer, C) ratio spectrum made from ROIs of the light-toned deposit (outlined in red) divided by plains material (outlined in cyan) and marked with arrows. This spectrum has bands near 1.94 and 2.23 μm that are consistent with palygorskite and/or hydrated non-crystalline Al/Si phases. Si-OH bearing phases on Mars are described in more detail by [10].

Acknowledgments: Lab spectra were measured at Brown/RELAB.

References: [1] Murchie S. et al. (2007) *JGR, 112,* E05S03, doi:10.1029/2006JE002682. [2] Pelkey S. M. et al. (2007) *JGR, 112,* E08S14, doi:10.1029/2006JE002831. [3] Mustard J. F. et al. (2007) *Nature,* submitted. [4] McEwen A. S. et al. (2007) *JGR, 112*. [5] Catling D. C. et al. (2006) *Icarus, 181,* 26-51. [6] Gendrin A. et al. (2005) *Science, 307,* 1587-1591. [7] Bishop J. L. et al. (2007) *7th Mars Conf.*, #3350. [8] Bishop J. L. et al. (2005) *LPSC XXXVI.*, #1456. [9] Bishop J. L. et al. (2004) *Icarus, 169,* 331-323. [10] Milliken R. E. et al. (2008) *LPSC*.