

CORRELATING SULFATES WITH THE AQUEOUS GEOCHEMICAL HISTORY AT JUVENTAE CHASMA, MARS. Janice L. Bishop¹, Catherine M. Weitz², Mario Parente³, Christoph Gross⁴, Arun M. Saranathan³, Yuki Itoh³, Muna Al-Samir⁴, ¹SETI Institute (Mountain View, CA; jbishop@seti.org), ²Planetary Science Institute (Tucson, AZ), ³University of Massachusetts (Amherst, MA), ⁴Freie Universität Berlin (Berlin, Germany).

Summary: Sulfates are investigated at Juventae Chasma using newly calibrated CRISM images that enable improved resolution of small outcrops and offer cleaner spectra that facilitate determining the chemistry of the sulfate minerals. Mound B inside Juventae Chasma harbors the greatest variety of sulfates including polyhydrated sulfates (PHS) consistent with starkeyite and rozenite, monohydrated sulfates (MHS) characteristic of kieserite and a MgFe-bearing MHS, as well as tiny outcrops of jarosite. The plateau region NW of the canyon contains thin units of hydrated material in light-toned layered deposits, some of which have an unusual spectral feature near 2.23 μm attributed to Fe hydroxy sulfate [1]. New spectral data of MHS samples [2] and Fe hydroxy sulfates [3] is enabling improved understanding of these outcrops.

Introduction: Sulfates on Mars provide important information about the aqueous geochemical environment and the Juventae Chasma region features multiple forms of sulfates containing different hydration levels and different cations, as well as mafic lavas and basaltic dunes. Juventae Chasma is located NE of Valles Marineris and is an expansive 5-6 km deep depression containing bright mountains of sulfates, while outcrops of olivine and pyroxene are found in the chaotic terrain towards the northern outflow at Maya Vallis [e.g. 1]. For this study we focused on Mound B, which exhibits the most variety of sulfate minerals (Figs. 1-2), and a section of the plateau where thin light-toned layered units including both hydrated materials and hydroxy sulfates occur (Figs. 3-5).

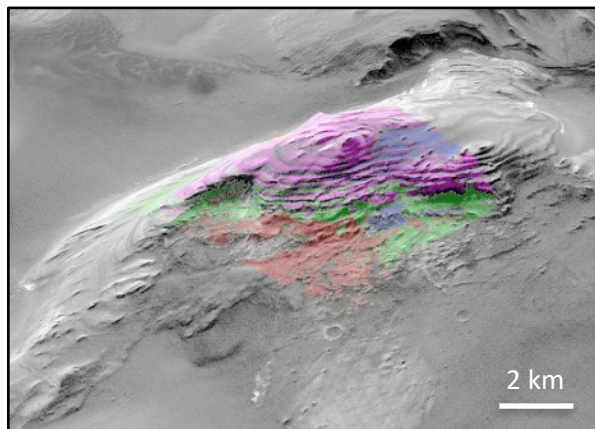


Fig. 1 Mound B, a bright sulfate-bearing mountain inside the canyon. CRISM mineral units over CTX on an HRSC DTM with kieserite in G, an MgFe-MHS in R, PHS in purple, and a mixed sulfate unit in B.

Methods: We used the Parente group algorithm for simultaneous atmospheric correction and denoising of CRISM images in the 1.0-2.6 μm spectral range that removes most of the residual atmospheric bands and spurious noise [4]. We processed CRISM images 9C0A and 5814 for this study, then applied a new mapping algorithm using hyperspectral components in the feature extraction to discriminate among spectral types [5]. Spectra were collected of 10x10 pixel regions from the larger sulfate outcrops and 3x3 pixel regions for the thin units without ratioing the spectra. CRISM mineral detections are merged with CTX and HRSC images over HRSC DTMs for regional stratigraphic views and over HiRISE images and DTMs for local stratigraphic views.

Results: *Mound B.* CRISM spectra (Fig. 2) of hydrated units include bands near 1.94 μm (blue), similar to the Mg sulfate starkeyite ($\text{MgSO}_4 \cdot 4\text{H}_2\text{O}$), but could also be due to hexahydrite or other Mg-PHS phases. Other PHS-type spectra (green) have a hydration band near 1.95 μm and a stronger shoulder near 1.98 μm that are more consistent with the spectrum of rozenite ($\text{FeSO}_4 \cdot 4\text{H}_2\text{O}$). These spectra also contain bands near 2.42 and 2.54 μm that provide confidence in the rozenite

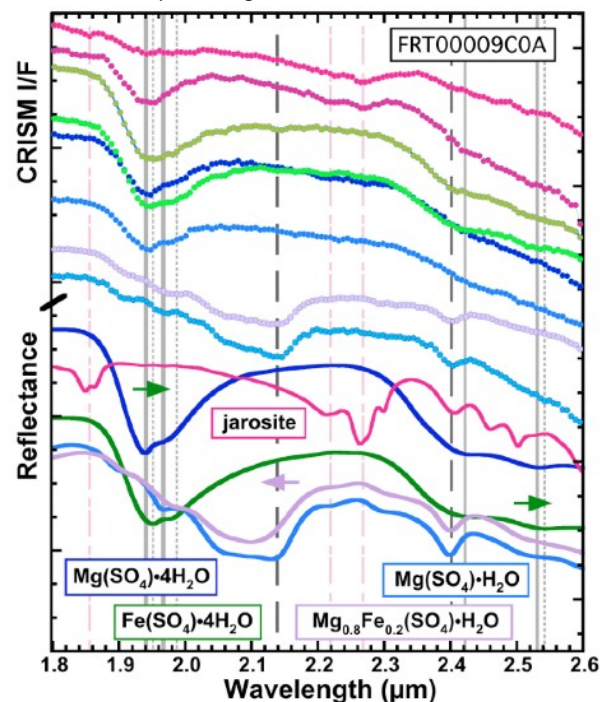


Fig. 2 CRISM spectra from Mound B including hydrated minerals characteristic of PHS (band at ~ 1.94 - 1.95 μm), MHS (band at ~ 2.11 - 2.13 μm), and jarosite (bands at 1.85, 2.22, and 2.27 μm) compared to lab spectra.

assignment. MHS type spectra with strong bands near 2.13 and 2.4 μm (light blue) are characteristic of kieserite, while similar spectra (purple) with both bands shifted towards shorter wavelengths likely contain a mixture of Mg and Fe. Lab spectra of kieserite and $\text{Mg}_{0.8}\text{Fe}_{0.2}\text{-MHS}$ [2] illustrate the effects of a small amount of Fe on the position of these bands. Small outcrops of jarosite-like units are also observed with a band at 2.27 μm and a shoulder at 2.22 μm (pink). One spectrum is anhydrous with an additional jarosite band at 1.85 μm , while the other is hydrated and is likely a mixture with PHS. Geochemical analyses indicate that hydrothermal fluids from leaching of meteorites and volcanic glass are consistent with these compositions [6].

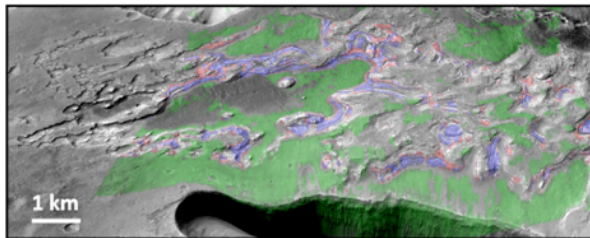


Fig. 3 Plateau region along the western rim of Juventae Chasma. CRISM mineral units over CTX on an HRSC DTM with hydroxy sulfate mapped in R, PHS mapped in B, and HCP mapped in G.

Plateau. Spectra were collected from the thin light-toned layered deposits where they are exposed under the caprock (Fig. 3). Some of these hydrated materials contain an additional feature near 2.23 μm (Fig. 4) that is not consistent with any currently defined mineral spectra. This band occurs at 2.236-2.238 μm in many locations, but is shifted towards shorter wavelengths in some places. Heated szomolnokite and MgFe-MHS produced hydroxy sulfates with similar features [3], where the spectrum of the 100% Fe sample has a band at 2.236 μm and the $\text{Mg}_{0.5}\text{Fe}_{0.5}$ -hydroxy sulfate sample has a band at 2.226 μm [3]. We also observed distinct pyroxenes above and below the hydrated units (Fig. 5).

Implications for Mars: These new results that reveal jarosite together with MHS and PHS in Mound B raise the possibility that the sulfates in the mounds could be related to the sulfates on the plateau. Continued investigation of the Juventae Chasma region may clarify any associations. The band near 2.23 μm , although rare on Mars, is observed at Aram Chaos [7], and Capri Chasma [8], as well as Juventae Chasma [1]. Preliminary mapping of this feature (Fig. 5) shows that it is associated with thin units of the hydrated material (potentially PHS) and may be present both above and below this hydrated component.

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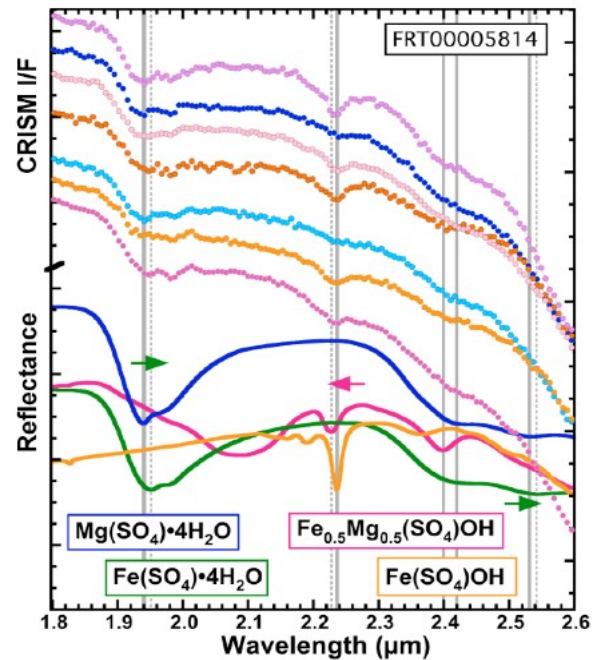


Fig. 4 CRISM spectra from the plateau region containing hydrated signatures consistent with PHS (blue) and an unusual band near 2.23 μm (pink-orange colors) attributed to hydroxy sulfates.

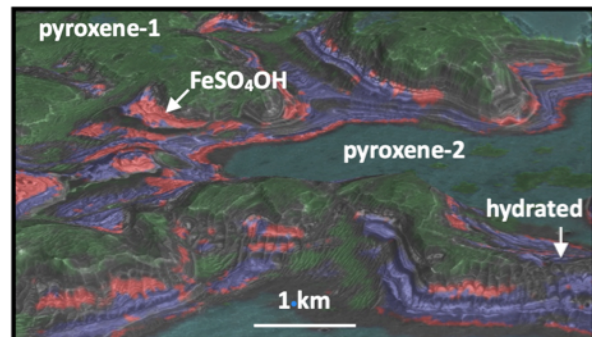


Fig. 5 Compositional units in the plateau region from CRISM mineral detections (FRT00005814) overlain on a HiRISE DTM with two forms of pyroxene in G, likely PHS in B, and the FeSO_4OH phase in R (N is left).

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