CHARACTERIZING UNUSUAL DEPOSITS AT IUS CHASMA, MARS. K. A. Wilk[1,2], J. L Bishop[2], Y. Itoh[3], A. M. Saranathan[3], M. Parente[3], C. M. Weitz[4], J. Flahaut[5], C. Gross[6], F. Seelos[7] [1]Rensselaer Polytechnic Institute (Troy, NY; wilkk@rpi.edu), [2]SETI Institute (Mountain View, CA; jbishop@seti.org) [3]University of Massachusetts at Amherst (Amherst, MA), [4]Planetary Science Institute (Tucson, AZ), [5]CRPG-CNRS (Vandoeuvre-Ies-Nancy, France), [6]Free University of Berlin (Berlin, Germany), [7]Johns Hopkins University Applied Physics Lab (Laurel, MD).

Introduction: Ius Chasma, located at the western end of Vallis Marineris, contains layered outcrops of hydrated materials **(**Figure 1**)**. Previous analysis of Ius Chasma observed unique surface materials that could be attributed to acid alteration [1]. Outcrops at Geryon Montes include unusual spectral "doublet" features in CRISM images, which are defined here as having two bands between 2.2 – 2.3 µm, and vary across the region. These spectra are unusual on Mars, where most phyllosilicate outcrops have either a band near 2.2 µm or a band at 2.3 µm, but not both.

Here we probed the mineralogy further, including components contributing to the spectral doublet features. This study aimed to characterize the spectral doublet features identified in the Geryon Montes outcrop in relation to mixtures of hydrated silica and phyllosilicates with sulfate minerals, including jarosite and gypsum, that could be forming through aqueous alteration of volcanic ash in the wall rock [2].

Characterizing the stratigraphy of these salty components in relation to phyllosilicates and hydrated silica will allow for improved understanding of the changing geochemical environments in which they formed.

Methodology: Newly developed calibration versions of CRISM images were analyzed to probe the mineralogy further, including components contributing to the spectral doublet features, as well as phyllosilicates found here. We utilized MTRDR images that include joined S and L image data and reduced spectral noise to provide improved spectra across the region of 0.4 to 3.9 µm [3], as well as a new algorithm employing simultaneous atmospheric correction and denoising that results in superior spectra of the surface from 1 to 2.6 µm [4]. Spectra from both methods were compared, verifying the integrity of both image processing methods**.**

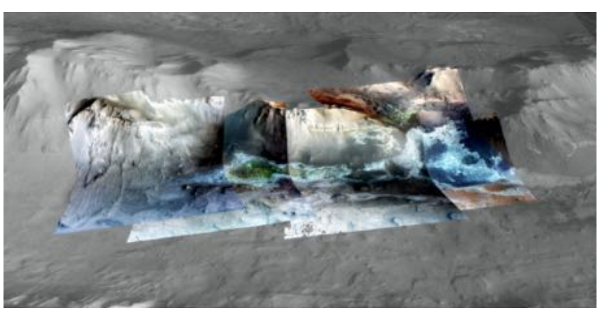
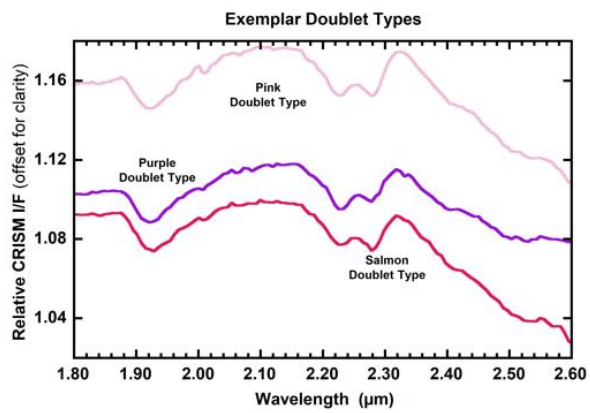


Figure 1: Mosaic of the CRISM false color images from the new image processing algorithm on top of a High Resolution Stereo Camera (HRSC) digital terrain model image.

Further, we employed a new feature extracting algorithm [5] based on Generative Adversarial Networks to identify locations containing specific spectral signatures that we are matching with lab spectra of expected minerals. We mapped subtle differences in the "doublet" materials and associated minerals in relation to neighboring outcrops using hyperspectral factors in the feature extraction rather than just one band, ratio, or slope in the spectrum **(**Figure 2**).**



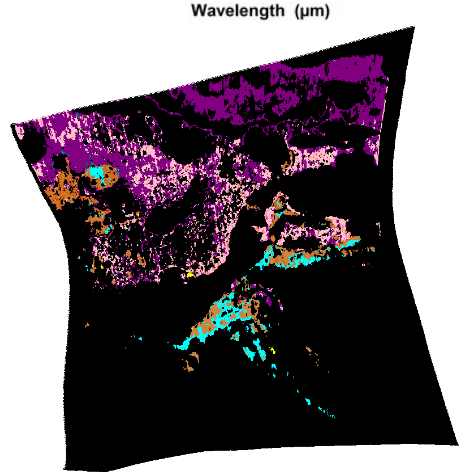


Figure 2: Compositional map of CRISM image FRT00009B27 from the new feature extracting algorithm. A) Exemplar doublets used to detect the doublet types indicated in pink, purple, and salmon. B) GuessMap image view based on likely spectral occurrences. Additional colors represent other minerals present near the doublet outcrops.

Results: Three different doublet types were identified at the Geryon Montes outcrop; they were characterized either having a stronger 2.2 µm band, a stronger

2.3 µm band, or equal intensity 2.2 and 2.3 µm bands. Specifically, the spectral doublets have one band near 2.21 – 2.23 µm and the other at 2.26 – 2.28 µm.

When analyzing the spectral doublet features, they displayed abundant variation even when compared to spectra averaged over several sites in the doublet outcrops in the identified region. Comparing the average doublet type for each region of Ius Chasma, Mars to lab spectra of minerals, the relative intensities and band centers of the spectral doublet feature most similarly matches those of acid treated smectites (Figure 3). This was reflected in the placement of the 1.41 µm band which is indicative of clays, whereas gypsum exhibits a broad 1.45 µm band and jarosite exhibits a sharp 1.47 µm band. The 1.9 µm band of the doublet material also exhibits the same band center as the acid treated smectite lab sample and reflects similarity in the 2.2 and 2.3 µm band centers, although the doublet bands are narrower (Figure 3).

This suggests that the doublet materials could in fact be an acid-altered clay, with the doublet variability attributed to differences in the solution chemistry, water/rock ratio, substrate, or extent of alteration.

The three doublet type materials also displayed spectral variations other than their defining doublet feature. When comparing the three doublet type materials, the doublet type characterized by having equal intensity 2.2 and 2.3 µm bands (pink) exhibits a stronger and narrower 1.9 µm band (Figure 4) indicating this unit is generally more hydrated than the other doublet materials and may contain smectites. The doublet material with a stronger intensity band near 2.2 µm (purple) has a broader band near 1.9 µm (Figure 4) that is more characteristic of sulfates including gypsum. The doublet type material characterized by having a stronger 2.3 µm band (salmon) consistently exhibits an iron band near 0.88 µm (Figure 4), which is indicative of nanophase ferric oxides similar to hematite, rather than goethite or ferrihydrite that would have a band at 0.91-0.93 µm [e.g. 6].

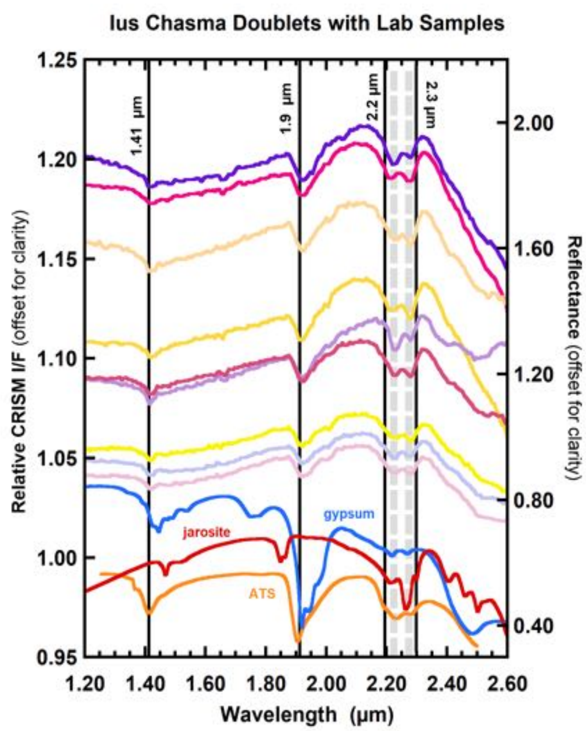


Figure 3: The average spectral doublet categories (purple, pink, and salmon) in CRISM images FRT00009B27, FRT0000A202, and FRT0000823A plotted with jarosite, gypsum, and acid treated smectite (ATS) lab spectra. The doublet feature is found between 2.2 – 2.3 µm with additional bands at 1.41 and 1.9 µm, with strong similarity to the acid treated smectite spectrum.

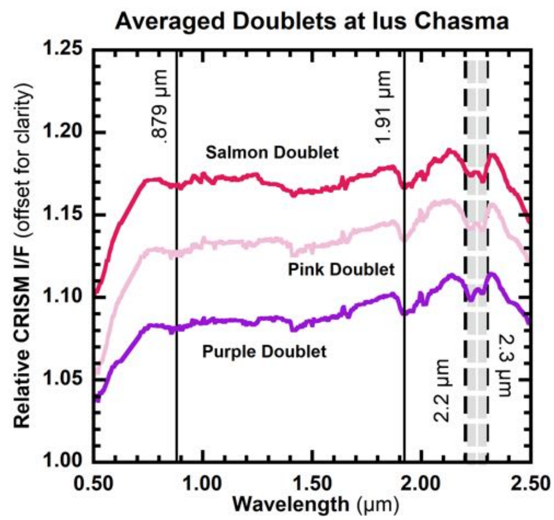


Figure 4: The average spectral purple, pink, and salmon doublet categories in CRISM images FRT00009B27, FRT0000A202, and FRT0000823A utilizing the MTRDR images.

In summary, our study demonstrates variations in these unique doublet spectral features at Ius Chasma, consistent with changing aqueous geochemistry across these units near Geryon Montes.

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References: [1] Roach L.H. et al. (2010) *Icarus* , 206 , 253 268, [2] Bishop J.L. et al. (2020) IEEE IGARSS , Abstract #1502, [3] Seelos F.P et al. (2016) *47th LPSC,* Abstract #1783, [4] Itoh Y. and Parente M. (2021) *Icarus,* 354, 114024. [5] Bishop J.L et al. (2020) *IEEE IGARSS*, Abstract #1502. [6] Bishop J.L. & E. Murad (1996) in Mineral Spectroscopy: A tribute to Roger G. Burns, 337-358.