**INVESTIGATING MINERALS AND ORGANICS IN THE JEZERO DELTA UTILIZING SHERLOC TEXTURE, FLUORESCENCE, AND HYDRATION OBSERVATIONS.** M.E. Minitti1, R. Bhartia2, S. Sharma3, A.E. Murphy4, K. Uckert5, Y. Phua5, R.A. Yingst6, R.S. Jakubek4, D.K. Buckner7, and A. Steele8. 1Framework (minitti@me.com), Silver Spring, MD; 2Photon Systems, Covina, CA; 3Jet Propulsion Laboratory, Pasadena, CA; 4Planetary Science Institute, Tucson, AZ; 5California Institute of Technology, Pasadena, CA; 6Jacobs, NASA Johnson Space Center, Houston, TX; 7University of Florida, Gainesville, FL; 8Earth and Planetary Laboratory, Carnegie Institution for Science, Washington, DC.

**Introduction:** In support of the Mars 2020 Perseverance rover investigation and sampling of the Jezero crater delta front and top, SHERLOC analyzed the texture, and deep UV Raman and fluorescence signatures of 9 unique abraded targets. SHERLOC Raman data reveal that sulfate is the dominant secondary phase in the delta front, and carbonate is dominant secondary phase in the delta top; the sulfate phases are variably hydrated while the carbonates exhibit no hydration [1]. Phosphate is also present as a minor phase [2]. [1] and [2] evaluated spectra from individual points within SHERLOC scans. In this study, we take advantage of the mapping capability of SHERLOC to group points within a scan by textural elements (e.g., grains, matrix, veins), and analyze the resulting averaged spectra which have higher signal to noise than that of an individual spectrum. We also average spectra by their fluorescence and hydration characteristics as a means of increasing signal to noise. The goal is to evaluate the Raman, fluorescence, and hydration signatures of these grouped elements and to seek signatures of minor phases, including organics, present within them.

**SHERLOC and Data Analysis:** SHERLOC is a deep UV (248.6 nm) Raman and fluorescence spectrometer paired with two cameras: Autofocus Context Imager (ACI) and Wide Angle Topographic Sensor for Operations and eNgineering (WATSON) [3]. WATSON images are used to colorize ACI images [4]. SHERLOC creates spectral maps by scanning its laser across a target and simultaneously collecting Raman and fluorescence spectra. Multiple map size, point spacing, and number of laser pulses per point (ppp) options are possible for a given scan. This study only utilizes 10x10 point, 1x1 mm scans acquired with 500 or 900 ppp. The spectra from each map were laser normalized and had cosmic rays removed between 275-360 nm via an automated algorithm [5]. We manually removed cosmic rays in the Raman region to avoid removing strong, narrow mineral peaks in this wavelength range. Signal to noise ratio was calculated by fitting a gaussian peak and dividing the amplitude above a linear baseline by the standard deviation in a quiet region from 2100 to 2200 cm⁻¹.

**Observations:** We present two example targets: one sulfate-dominated and one carbonate-dominated.

**Sulfate example.** The “Uganik Island” abrasion was created within the “Cape Nukshak” section of the delta front [6]. Uganik Island is comprised of sulfate-dominated siltstone with cm-scale veins [7]. One particular vein was analyzed on multiple sols (Fig. 1).

![Figure 1: Colorized ACI image of SHERLOC footprints (1x1 mm) within Uganik Island. Labels note sol and scan order. Blue points exhibit hydration features (relative strength: dark blue=cyan). Pink box marks boundary of Fig. 2 inset image.](image)

The initial analysis of an irregularly-shaped white/gray vein revealed a ring of intense fluorescence around the perimeter of the vein (Fig. 2). The fluorescence signature is a doublet with peak centers at ~7400 cm⁻¹ and 9500 cm⁻¹ (~305 and 325 nm) with varying degrees of intensity correlating with texture (Fig. 2). All the textures exhibit Raman v1 sulfate peaks with similar peak centers (~1018 cm⁻¹), and the vein and rim also exhibit v3 sulfate peaks at ~1125-1134 cm⁻¹; the matrix has a weak v3 sulfate peak. The positions of the v1 and v3 peaks are consistent with anhydrite [1]. No mineral features other than sulfate are apparent in the strongly fluorescing rim. Fluorescence and sulfate Raman intensity do not correlate. Organic molecules fluoresce in this wavelength region [4] but Ce³⁺ in anhydrite also exhibits doublet fluorescence at 305 and 325 nm [4,8,9].

While the v1 and v3 features in all scans are consistent with anhydrite, weak (SNR=12) hydration
features (stretching mode ~3400 cm⁻¹) are present in a subset of the scan averages (Fig. 3). Hydration features (blue points, Fig. 1) are found within the vein, both in the vein interior and within the strongly fluorescing rim, but not within the matrix. Averaging only points that exhibit the strongest hydration signatures (Fig. 1) does not shift the v₁ and v₃ positions of the sulfate peaks, but minor peaks appear in the average hydrated spectra that are not present in the whole scan averages (blue arrows, Fig. 3). The peak at ~1350 cm⁻¹ (SNR=9.6) is a minor sulfate peak, and the peak at ~2034 cm⁻¹ (SNR=6.6) is a harmonic to the v₁ peak. Both are apparent because of the strong v₁ intensity of the sulfate. The other minor peak present in the strongest hydration spectra (~1600 cm⁻¹, SNR=5) could be associated with sulfate and/or hydration. Further comparisons to laboratory spectra are required to assess if the feature at ~1600 cm⁻¹ can be explained as a hydration bending mode. If it cannot be assigned to a minor sulfate peak or hydration bending, organic carbon is another possible source as it exhibits Raman features between 1500-1700 cm⁻¹ [10].

**Carbonate example.** The “Thornton Gap” abrasion was created at the base of a cliff of resistant, pebbly sandstone layers marking the top of the “Hawksbill Gap” section of the delta front [6]. Outside of the 330-350 nm fluorescence commonly, but not exclusively associated with phosphates detected by SHERLOC and PIXL [2], Thornton Gap does not exhibit fluorescence above instrument background levels.

Texture and color variations are clear in the colorized ACI image (Fig. 4 inset), but these variations do not have distinctive Raman variations (Fig. 4). The v₁ peak at 1086 cm⁻¹ is consistent with carbonate with magnesite and siderite compositions [1,11]. No hydration is observed. The broad hump between ~1450-1700 cm⁻¹ (SNR=3.8) is also observed in other carbonate-bearing samples from the delta front and top. Peak fitting the broad hump requires three features near ~1450, 1600, and 1700 cm⁻¹. The 1450 and 1700 cm⁻¹ features can likely be assigned to v₃ and 2 v₂ carbonate features found at these wavelengths for multiple carbonate chemistries [11]. Further peak modeling is required, but if the 1600 cm⁻¹ peak is required to best fit the broad hump, organic carbon could be the source of the 1600 cm⁻¹ feature [10].