ANALYSIS OF CO-LOCATED SUPERCAM AND SHERLOC OBSERVATIONS ON ABRASION PATCHES IN JEZERO CRATER. S. A. Connell[1], R. C. Wiens[1], E. L. Cardarelli[2], R. Deen[2], L. Mandon[3], S. Sharma[2], O. Beyssac[4], E. Clavé[5], S. Siljeström[6], A.I. Czaja[7], P. Pilleri[8], O. Gasnault[8], G. Lopez-Reyes[9], J.R. Johnson[10], R. Bhartia[11], S. Maurice[8], SuperCam and SHERLOC teams. [1]Purdue University, [2]JPL/Caltech, [3]Caltech, [4]UPMC Paris, [5]U. Bordeaux, [6]RISE, [7]U. Cincinnati, [8]IRAP Toulouse, [9]U. Valladolid, [10]Johns Hopkins University, [11]Photon Systems, Inc.

Introduction: On the Mars2020 Perseverance rover the SuperCam [1, 2] and Mast Camera Zoom (Mastcam-Z) [3] acquire a variety of remote sensing data, while the Scanning Habitable Environments for Raman and Luminescence for Organics & Chemicals (SHERLOC) [4], and Planetary Instrument for X-ray Lithochemistry (PIXL) [5] acquire proximity observations.

Co-registered images among these data sets can be used to cross-correlate spectral data for specific regions of interest (ROI) and aid in identifying specific mineral grains. Generally, such products consist of overlays on SHERLOC's WATSON images and include the spectral points of SuperCam rasters, SHERLOC maps and PIXL maps. Previous work was done on PIXL and SHERLOC co-locations [6]. Here we present the co-location of overlapping SuperCam and SHERLOC observations using co-registered images and data. We investigate abrasion patches acquired in the Crater Floor Campaign, which allow instruments to observe the exposed rock's mineral heterogeneity, grain size, distribution, and true color [7].

Abrasion Patches: The rover is equipped with a rotary-percussive drill with a rock abrading bit to reveal the martian subsurface by removing surface weathering [7] of dust coatings and rinds. After the surface abrasion occurs, dust removal is performed by the Gas Dust Removal Tool (gDRT) [7]. The gDRT ensures that the flat surface of the abrasion patch is clear of any surface dust so that precise targeting in the abrasion patch can be done with little interference of dust particles [7].

SuperCam is a remote-science instrument that includes laser-induced breakdown spectroscopy (LIBS), that provides elemental chemistry by ablating small spots on the martian surface [1, 2]. In addition, visible (0.40-0.85 μm) and near-infrared (1.3-2.6 μm) (VISIR) reflectance spectroscopy and Raman spectroscopy are used to characterize mineralogy at mm-scales. A remote micro-imager provides high-resolution color context imaging [1, 2].

SHERLOC is a proximity instrument with a deep ultraviolet (UV) Raman and fluorescence spectrometer that includes a context microscopic imager with a resolution of 10.1 μm/pixel [4]. The scanning laser has a spot size of 100 μm, allowing it to produce spatially and spectrally resolved data with an approximate standoff of 5 cm from the abraded martian surface [4].

Co-located Analyses: Two abrasion patches from the Crater Floor Campaign in Jezero Crater, Bellegarde and Dourbes, exhibit partially overlapping SuperCam and SHERLOC spectral points shown in co-registered images here.

Bellegarde: The Bellegarde abrasion (Fig. 1) was made on the Rochette rock atop the Artuby Ridge igneous outcrop. Multi-instrument observations [8] indicated a lithology consisting of fine-grained, primarily mafic minerals, including pyroxene, plagioclase, and Fe-Ti oxides. Secondary minerals included iron oxides, Ca-sulfates (occasionally hydrated), phosphate, and minor carbonate, indicative of aqueous alteration [8].

SuperCam IR spectra (Fig. 2) were variable but exhibited a ~1.4 μm (OH) absorption and a strong ~1.9 μm (OH/H_2O) band indicative of hydration. Absorption bands were present at ~2.3 μm (Mg/Fe phyllosilicate/carbonate), and near 2.4 μm (attributed to sulfate).

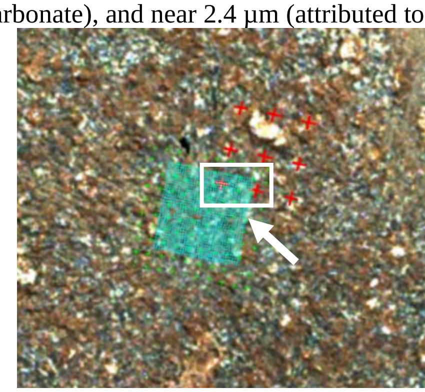

Figure 1. WATSON (Sol 185), showing a portion of the 10-mm deep Bellegarde abrasion patch [6], with overlapping co-located SuperCam and SHERLOC observations indicated by the ROI (white box). Sol 187 SuperCam spectral point locations are shown as the 3x3 grid (red crosses). SHERLOC's Sol 186 10x10 HDR scan (500 pulses/point, small, light green crosses) covers a 7x7 mm area, and the 36x36 survey scan (Sol 186) covers a 5x5 mm area (15 pulses/point, blue-green box).

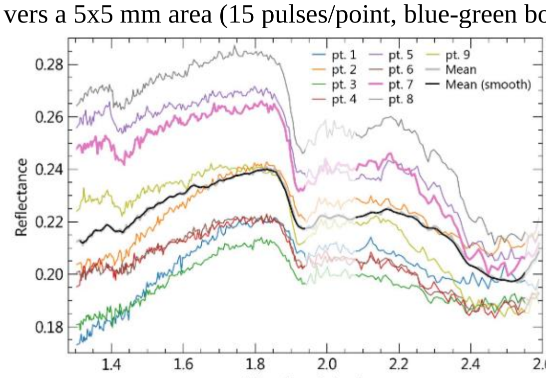

Figure 2. SuperCam IR spectra with a wavelength range of 1.3 – 2.6 μm for all 9 points in Bellegarde.

Note that SuperCam raster points 1 and 2 overlap the SHERLOC 10x10 and 36x36 scans, and the IR spectra show a 1.9 µm absorption band, and very weak 2.3 and 2.4 µm absorption bands. The LIBS spectra for points 1 and 2 indicates SiO_2 abundances of 21.1 wt.% (point 1) and 42.3 wt.% (point 2). SHERLOC Raman spectra detected hydration, possible amorphous silicate, Ca-sulfate, carbonate, and phosphate in the abrasion patch (Fig. 3). The "amorphous silicate" from the SHERLOC Raman data may be weak/broad Raman bands of silicates and are being further evaluated [9].

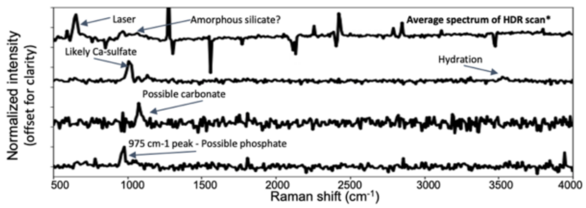

Figure 3: SHERLOC Raman spectra from 500 – 4000 cm^{-1} showing mineral peaks and hydration (labeled) [8].

Dourbes: The Dourbes abrasion (Fig. 4) was in the Séítah South region acquired on the Brac rock. Multi-instrument observations [8, 10, 11] indicated a lithology consisting of a medium-to-coarse-grained poikilitic olivine cumulate rock. The primary minerals were olivine and pyroxene [8]. Minor sulfates, carbonates, and hydrated phases were indicative of some aqueous alteration [8]. Organic fluorescence spectra consistent with aromatic organic matter was also detected [8, 12]

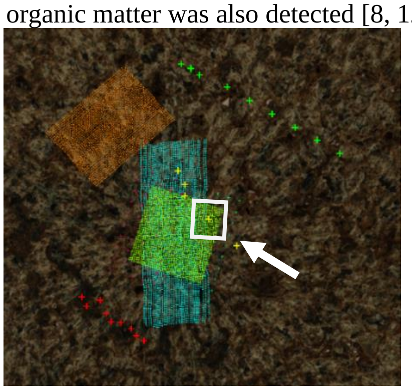

Figure 4. WATSON (Sol 253), showing a portion of the 7-mm deep Dourbes abrasion patch [6], with overlapping co-located SuperCam and SHERLOC observations (white box). The Sol 278 SuperCam 5x1 raster points overlap SHERLOC (yellow crosses). Other SuperCam observations (red, green crosses) did not overlap SHERLOC. The Sol 257 SHERLOC 36x36 survey scan (15 pulses/point, 5x5 mm) is in green, and the Sol 269 10x10 HDR scan (500 pulses/point, 7x7 mm) is in pink and blue. The elongated blue scan and the orange scan are PIXL data not included in this analysis.

SuperCam IR spectra (Fig. 5) overall show a steep slope from 1.4 – 1.8 µm, indicative of olivine. Other features are 1.9 µm (hydration) and 2.3 µm (Mg/Fe phyllosilicate/carbonate) absorption bands. Note that SuperCam raster point 4 overlaps the SHERLOC 10x10 and 36x36 scans, showing IR spectra exhibiting 1.9 µm and 2.3 µm absorption bands. The LIBS spectra for point 4 indicates 46.0 wt.% SiO_2. SHERLOC Raman detected hydration, Ca/Mg-sulfate, carbonate, olivine, and potential pyroxene or sulfate.

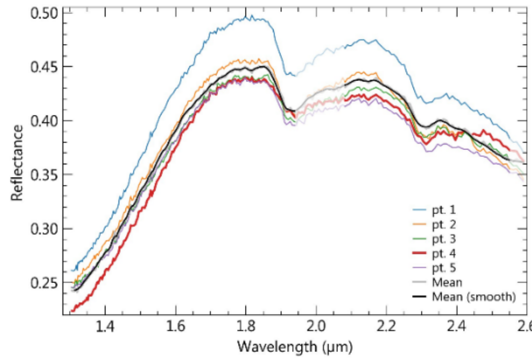

Figure 5. IR spectra of Dourbes for all 5 points representing the SuperCam 5x1 raster.

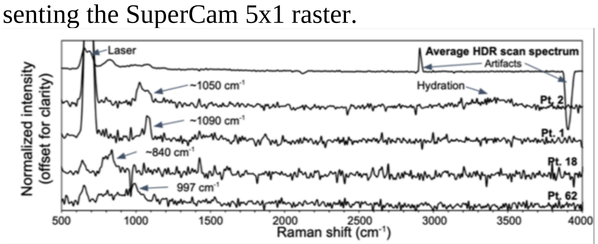

Figure 6: SHERLOC Raman spectra of Dourbes showing mineral peaks and possible hydration (labeled) [8].

Discussion and Conclusion: Abrasion patches provide a petrographic window into the lithology and stratigraphy of Jezero. The abraded surfaces exhibit igneous petrology with aqueous alteration due to the presence of hydrated minerals detected by both instruments. In future work, microanalyses will extract spectral points from ROIs (shown in figures 1 and 4) of overlapping spectral observations to compare the results from SuperCam and SHERLOC. We will compare their geochemistry, mineralogy, and hydration for their astrobiological potential. In addition, data will be analyzed to determine how the different fields of view and sensitivities affect the results from each instrument.

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References: [1] R.C. Wiens + (2021) SSR 217, 4. [2] S. Maurice + (2021) SSR 217, 47. [3] J.F. Bell + (2021) SSR 217, 24. [4] R. Bhartia + (2021) SSR 217, 58. [5] A.C. Allwood + (2020) SSR 216, 134. [6] J.R. Hollis + (2022) Icarus 387, 115179. [7] Moeller + (2021) SSR 217, 5. [8] MARS2020 INITIAL REPORTS, Crater Floor Campaign (2022). [9] R. Morris + (2023) this meeting. [10] E.L. Scheller + (2022) Science 378, 1105–1110. [11] M.M. Tice + (2022) Sci. Adv. 8, eabp9084. [12] S. Sharma + (2022) in review.