MARS2020 IN SITU INVESTIGATION OF ALTERATION AT JEZERO CRATER. A.J. Brown[1], R.C. Wiens[2], S. Maurice[3], K. Uckert[4], M. Tice[5], D. Flannery[6] R.G. Deen[4], J.D. Tarnas[4], A.H. Treiman[7], K. L. Siebach[8] L.W. Beegle[4] W.J. Abbey[4], J.F. Bell[9], J.R. Johnson[10], L.E. Mayhew[11], J.I. Simon[12], J.A. Hurowitz[13], O. Beyssac[14], P.A. Willis[4], R. Bhartia[15], R.J. Smith[13], T. Fouchet[16], C. Quantin-Nataf[17]. [1]Plancius Research, MD (adrian.j.brown@nasa.gov). [2]LANL. [3]IRAP, Toulouse, France. [4] Jet Propulsion Laboratory, California Institute of Technology. [5]School of Geosciences, Texas A&M University. [6]QUT, Queensland, Australia. [7] LPI/USRA. [8] Rice University, Houston, TX. [9]ASU, Tempe AZ. [10]JHUAPL, Columbia, MD. [11]CU Boulder, CO. [12] NASA JSC, Houston, TX. [13] Dept. Geosciences, Stonybrook University, NY. [14]IMPMC, Paris, France. [15]Photon Systems Inc., Covina, CA. [16]Observatoire de Paris, France.[17] Université de Lyon, LGL-TPE, France.

Introduction: Mars2020 will land at Jezero crater on February 18th 2021 [1]. The M2020 science team has conducted mapping of the crater at the 1:75,000 scale in preparation for the landing [2]. The team has also identified several lithologies along the traverse for potential sampling. These will be of high scientific interest to the team and the planetary science community upon their intended return to Earth planned for 2031.

Olivine-carbonate lithology: The olivine-carbonate lithology is among the best documented rock types in Jezero crater and the surrounding watershed [3] and is potentially among the most astrobiologically compelling units in the region [5]. From VNIR reflectance spectra, the unit contains abundant olivine (Fo#45-66) in large grains (>500 microns, due to band saturation) accompanied by clay and carbonate minerals [4], and its crater-retention-age is ~3.82Ga [6]. The olivine-carbonate progenitor lithology may have been deposited as a pyroclastic ash flow at low temperature [10], although other origins are possible [4]. The transition from igneous ash-flow to the olivine-carbonate-clay could have been from deuteric serpentinization and talc-carbonation [7] perhaps caused by late Noachian CO_2 outgassing [8]. It is also possible that the olivine was altered to carbonate when it was exposed to a thick CO_2-rich Noachian atmosphere [9]. Discrimination between these formation and alteration histories is critical to advancing our understanding of Noachian mantle circulation [11-12].

Mars2020 Instrument suite: The *Perseverance* rover carries a compelling instrument suite for *in situ* and remote investigation of the rocks and other solids. In particular, PIXL [13] and SHERLOC [14], mounted on the rover arm, will be capable of co-registration of their results. SuperCam [15] and Mastcam-Z [16] will also be able to help characterise the rock surfaces and interiors prior to sampling. We will discuss here the current effort to coordinate the observations of these four instruments in order to characterise the lithologies presented to the rover.

Methods: We use the olivine-carbonate lithology in this study as an example of the rocks at Jezero to which multi-instrument analyses will be applied. We may not encounter this lithology immediately upon arrival, but the approach we describe is broadly applicable to whatever units we encounter.

In Fig. 1 we show an outline of the approach we are adopting here to differentiate between end-member mechanisms of talc-carbonate and serpentinisation. Shown in the figure are two examples from the ultramafic Archean Dresser Formation in Western Australia. Olivine replaced by serpentine and carbonate are seen in a petrographic thin section in the green "PIXL" panel. Raman spectra of talc are shown in the red "SuperCam+SHERLOC" column (VISIR spectra will also be used to constrain mineralogy). In the brown "MastcamZ" column are shown visible images of these samples in the field. We now outline the contributions of each instrument in detail.

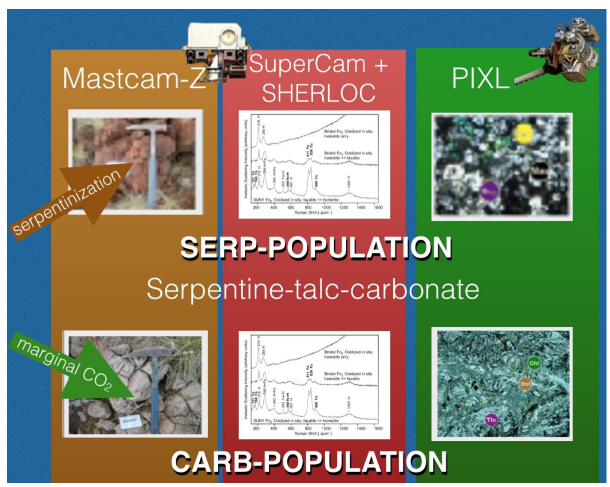

Figure 1 - Outline of approach for differentiating alteration styles of the olivine-carbonate lithology using M2020 instrumentation suite.

Mastcam-Z: The Mastcam-Z instrument will obtain multispectral images extending to ~1020nm [16]. Its images will be used to locate olivine via its absorption band centered near 1 μm [17]. Mastcam-Z Bayer-filter mosaics supported by multispectral observations will enable surveys of both near-field and distant targets during the Perseverance traverse.

SuperCam: SuperCam Raman and VISIR observations will permit rapid identification of mineralogy - likely minerals in the olivine-carbonate lithology (including clays, serpentine and talc) have distinctive Raman spectra [19]. SuperCam carries on-board calibration standards including olivine, serpentine, and carbonates. SuperCam can scan at the mm scale, which will provide local context for the more detailed observations of PIXL and SHERLOC.

PIXL: PIXL will provide elemental composition of its target via x-ray fluorescence at the 100 µm scale. These data will permit determination of Fo# of olivines, compositions of other minerals, and recognition of minerals too rare or dark to be detected using Raman.

SHERLOC: SHERLOC Raman will be used for the identification of carbonates, sulfates and clays at a grid of points within the *in situ* FOV (Fig. 2). SHERLOC will also supply information for the discrimination of oxidation state of clays within the lithology [19].

iSDS co-registration with CRISP/CRUST: Due to the importance of correctly identifying observations of the same large grains in the mafic matrix with multiple instruments, some form of co-registration plan is required. Co-registration of Raman and XRF spectroscopy datasets from a confocal system operating on a robotic platform has been demonstrated [20]; data co-registration from multiple hyperspectral instruments that do not necessarily interrogate identical points requires additional processing. Here we outline two aspects of the plan: the iSDS system for registration of SHERLOC and PIXL shots to context images, and the CRISP/CRUST software that overlays these on any other image of the workspace.

ISDS: The SHERLOC and PIXL Instrument Science Data System (iSDS) pipelines will automatically process raw data as it is downlinked to generate reduced, calibrated science products. In this data processing pipeline, laser or X-ray shots are registered to Autofocusing Contextual Imager (SHERLOC) or MicroContext Camera (PIXL) images, respectively, allowing for correlation of spectral variability with morphological features. Robotic arm movement, (e.g. drift from thermal expansion), is also corrected for using feature tracking algorithms across multiple images.

CRISP/CRUST: The Instrument Data System (IDS) generates the initial products for all instruments, which feed into iSDS and other places. IDS performs correlation-based image coregistration across images from all cameras at each rover location. This creates a mapping between images, stored in the CRISP database, that allows images to be overlaid on each other using the IDS Marviewer tool, or other tools. IDS also maintains the CRUST database, which contains the location of each spectral observation in its context image. The combination of these allows the location of spectral observations from any of PIXL, SHERLOC, or SuperCam to be plotted on any other image, thus enabling better interpretation of the scientific context of the spectral observations (see Fig. 2).

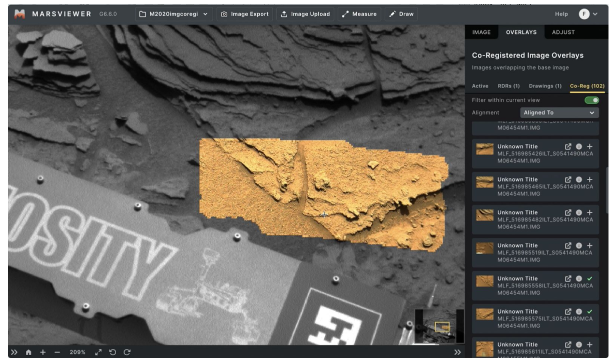

Figure 2 - Example of CRISP, showing (MSL) Mastcam coregistered with and overlaid on Navcam in the Marsviewer tool.

Take away messages: 1.) We have previously used CRISM datasets to map variations in the shape and centroid of the olivine 1 µm band in the Jezero crater and watershed and placed bounds on the grain size and Fo# of the olivine-carbonate lithology [4]. **2.)** We used the variations in 2.5 µm (carbonate) and 2.3 µm (clay and carbonate) bands to show that the most red shifted olivines are not accompanied by clays or carbonates. We have previously hypothesised these clay-carbonate signatures could be due to serpentinisation or talc-carbonate alteration. **3.)** In order to test this hypothesis, we have outlined a plan to utilize the instrumentation of the *Perseverance* rover to search for these characteristics and determine their variations around Jezero. We fully expect the co-registration work outlined here to be of use to other remote and in situ investigations of the geology of Jezero crater and delta.

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