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] J.D. Tarnas[4], A.H. Treiman[7], R.G. Deen[4], K. L. Siebach[8] Luther W. Beegle[4] William 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], [1]Plancius Research, MD (adrian.j.brown@nasa.gov) [2]LANL, [3]IRAP, Toulouse, France [4] Jet Propulsion Lab, Pasadena, CA, [5]School of Geosciences, Texas A&M University, TX, [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

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: One of the well-documented lithologies is the olivine-carbonate lithology, which is present in the Jezero watershed and crater [3] and has recently been constrained to have olivine with large grain sizes (>500 microns, due to band saturation) and Fo#45-66 and is usually accompanied by clay with carbonates [4]. This unit has the potential of being the most astrobiologically compelling unit in Jezero [5], and has estimated surface crater-age of 3.82Ga [6]. The olivine-carbonate lithology has been hypothesized to have undergone a history of deuteric serpentinization and talc-carbonation as a result of co-occurring olivine, carbonate and clays [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]. Kremer et al. suggested that the unit was deposited as a pyroclastic ash flow at low temperature [10]. Discrimination between these formation and alteration histories is critical to advancing our understanding of the evolution of mantle circulation in the Noachian [11-12].

Mars2020 Instrument suite: The *Perseverance* rover provides a compelling instrument suite for in situ and remote investigation of the rocks it will encounter. 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 subsurfaces 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 our intention is to study potentially mafic units first encountered on the crater floor as they are reached using this approach.

In Fig. 1 we show an outline of the adapted approach we are adopting here to differentiate between end-member examples 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.

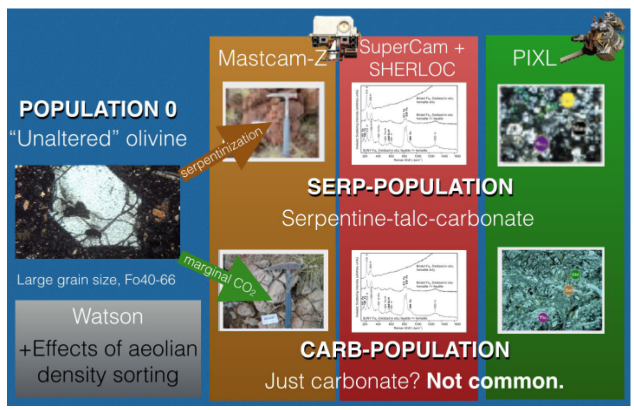

Figure 1 - Outline of approach for differentiating alteration styles of the olivine-carbonate lithology using M2020 instrumentation suite.

Mastcam-Z: The Mastcam-Z instrument will obtain multispectral images extending to ~1020nm [16]. Mastcam-Z images will be used to constrain prospective olivine by investigating the near-infrared downturn associated with the 1 µm olivine band [17]. The large volume of Mastcam-Z observations and mosaics will allow us to carry out a large scale survey of the Jezero crater during long periods of driving.

SuperCam: SuperCam Raman and VISIR observations will be used to analyse and identify the clays present in the olivine-carbonate lithology, as well as identifying olivine, serpentines, carbonates, and talc. These observations will also be co-registered with PIXL and SHERLOC in situ observations when they are obtained. SuperCam can scan at the mm scale, while the arm instruments will focus on observing at the mineral assemblage level. SuperCam carries on-board calibration standards including olivine, serpentine, and carbonates.

PIXL: PIXL will be used to obtain the equivalent of a rock thin section with XRF spectra within it, allowing us to measure the Fo# of olivines, and the major element constituents of the large grained materials present, for example, olivine, carbonates and clays.

SHERLOC: SHERLOC will be used for the identification of carbonates, sulfates and clays at a grid of points within the in situ FOV (Fig. 2) [18]. SHERLOC will supply crucial supporting information for the discrimination of the post-emplacement alteration that has occurred within the lithology.

Co-registration with CRISP/CRUST and iSDS: 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 [19]; 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. As part of this data processing pipeline, laser or X-ray shots are registered to ACI or MCC context images, respectively, allowing for correlation of spectral variability with morphological features. Robotic arm movement, including 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 Figure 2).

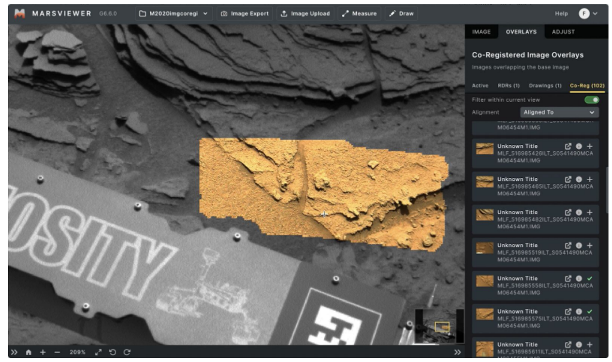

Figure 2 - Example of CRISP, showing (MSL) Mastcam coregistered with and overlaid on Navcam in the Marsviewer tool.

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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