JEZERO WATERSHED MAPPING OF OLIVINE-CARBONATE LITHOLOGY. A. J. Brown, T.A. Goudge, and C.E. Viviano. 1Plancius Research, Severna Park, MD (adrian.j.brown@nasa.gov) 2Jackson School of Geosciences, University of Texas, TX, 78712, 3Johns Hopkins Applied Physics Laboratory, MD, 20723

Introduction: The Jezero Crater and its well exposed delta has been selected as the landing site for the Mars 2020 Rover [1]. Along with a number of other sites in the Nili Fossae region, Jezero has been found host to relatively large exposures of olivine and carbonate [2]. Using full resolution data from the CRISM instrument, we have mapped olivine and carbonate signatures present in Jezero Crater and its surrounding watershed (Fig. 1) [3]. Here we show that by using the variations in the olivine 1 μm band we can place bounds on the composition and grain size and reveal a hitherto unknown relationship between the olivine 1μm band signature and carbonates and phyllosilicates.

Jezero Crater Olivine-Carbonate: Previous spectroscopic and geomorphic mapping has revealed that the olivine-carbonate lithology is present in the watershed and in Jezero crater [4]. “Marginal carbonates” around the rim of the crater have also been interpreted as lake deposits [5]. In this study, we wish to examine the relationship between the spectroscopic properties of olivine throughout the Jezero watershed, to determine how these are related to clay and carbonate signatures and assess how similar the carbonates inside Jezero are to those in the watershed, and thereby provide better constraints on the origins of the olivine unit and its associated alteration mineralogy. Buffered crater counts of the fluvial valleys associated with the Jezero paleolake indicate that this system ceased activity by approximately the Noachian-Hesperian boundary, similar to the timing of other large valley network systems on Mars [6] and this may be the final time water flowed on Mars [7].

Methods: We used CRISM half and full resolution datasets [8] and an iterative Asymmetric Gaussian approach [9] to track variations in band center and shape. We applied a threshold to the four parameters of the fit (centroid, asymmetry, width and amplitude) to eliminate noisy and non-olivine bearing pixels.

In Fig. 1 we show the region of interest of this study, indicating the location of our three CRISM images (HRL40FF, FRT9712 and 3E12) and the outline of a geomorphic map produced by Goudge et al. [4]. Overlaid in green is the geomorphic map of Kremer et al. [13] associated with the olivine-carbonate lithology.

Results: Fig. 2 shows a “Shkuratov plot” inspired by Figure 11 of [10]. It plots the relationship between the asymmetry and the 1 μm centroid position for the olivine 1 μm band, for different Fo# of olivine spectra from [11]. The points from FRT3E12 (red) and HRL40FF (outlined blue) are plotted to show the CRISM results.

Fig. 1 – The region of interest for this study, overlain in green by the olivine lithology map of Kremer et al. [13].

Fig. 2 - “Shkuratov plot” showing dependence of olivine centroid and asymmetry parameter on composition and grain size based on the laboratory Fo# series of [11]. The points from FRT3E12 (red) and HRL40FF (outlined blue) are plotted to show the CRISM results.

Edwards and Ehlmann [12] carried out a Hapke fit to a CRISM spectrum in Nili Fossae (FRT C968), north of Jezero, in the olivine-carbonate lithology. They reported an olivine of 1mm grain size and Fo60 was required to fit the olivine 1μm band adequately.
We plot their result in Fig. 2, and note two things:
1.) The Edwards and Ehlmann spot measurement is reasonable for the location from which it was taken, however is not indicative of the full range of olivine composition. The points from 3E12 (red shaded in Fig. 2) have a considerable tail that extends to the right of the [12] Fo60 estimate. This corresponds to a centroid of ~1.43µm, which intersects the red 1mm line just to the right of Fo41. Assuming a grain size of 1mm allows us to place a lower bound of Fo40 on the composition of the olivine in FRT3E12, where it is best exposed. The accuracy of our method means shows we can estimate the composition as Medium Fo (40-66).
2.) Fig. 2 gives us a way to place an upper and lower limit on the grain size of the olivine in FRT3E12. We do this in two different ways. A maximal value of 1mm brackets the top values of the red shaded area, and a lower limit of 500 microns is required to fit the range of asymmetry/centroid observations. Lower grain sizes (e.g. the green 70 micron curve) cannot explain our observations in FRT 3E12.

**Correlations with carbonates and phyllosilicates:** Fig. 3 was designed to show the hitherto unrecognised correlations of the olivine 1 µm band position with carbonates and clays. We have plotted Shkuratov plots for the asymmetry and 1 µm centroid, and colourised with the 2.3 (left) and 2.5 µm (right) bands for our three CRISM FRT images. The figure shows that for the bottom row (FRT3E12), the most extreme redshifted 1 µm band pixels are not associated with carbonates or phyllosilicates (there are no red points in the blue ellipses in C and F). This behaviour is not seen in A and D for HRL40FF, where the most redshifted olivines are accompanied by carbonates and phyllosilicates. This relationship hints at differing styles of alteration in 3E12 and 40FF, and this is likely to be investigated by the Mars 2020 rover, which will land near the location of HRL40FF.

Finally, Fig. 3 demonstrates that the centroid position of the carbonates covers the same range (1.2-1.3 µm), as seen in the red ellipses in D-F by the presence of red pixels at these points.

**Take away messages:** 1. We have used CRISM full resolution datasets to map variations in the shape and centroid of the olivine 1 µm band in the Jezero crater and watershed (Fig. 1).
2. We have used the variability of the olivine 1 µm band in the Jezero watershed to place bounds on the grain size and Fo# of the olivine-carbonate lithology (Fig. 2). Our observations show that where the olivine is best exposed (e.g. FRT 3E12) the olivine grain size must be at least 500 microns, and at most 1mm. Assuming the grain size is 1mm allows us to place a bound on the composition of the exposed olivine-carbonate lithology as Fo40-66 (Fig. 2).
3. We have used the variations in 2.5 µm (carbonate) and 2.3 µm (clay and carbonate) bands to show that in FRT 3E12, the most redshifted olivines are not accompanied by clays or carbonates. We term these locations “population zero” olivines. This behaviour is not seen in 40FF, at the location of Jezero crater.

**Acknowledgements:** Work supported by NAI grant NNX15BB01A/MDAP grant NNX16AJ48G.