**COMPOSITIONAL HETEROGENEITY OF MARGINAL CARBONATE UNIT: HINTS FROM BAND MINIMUM MAPPING OF JEZERO CRATER ON MARS.** B. Ye[1], J. R. Michalski[1], Y.L. Li[1], J. Liu[1], Y. Qian[2], [1]Department of Earth Sciences and Laboratory for Space Research, University of Hong Kong, Hong Kong SAR, China (binlongy@hku.hk), [2]State Key Laboratory of Geological Processes and Mineral Resources, School of Earth Sciences, China University of Geosciences, Wuhan, China.

**Introduction:** Jezero crater once host an open basin lake with inlet and outlet channel and deltas, indicating a period of sustaining aqueous activity [1, 2]. The crater walls, deltas and floor deposits are mineralogically diverse including Fe/Mg-rich clay minerals and subaqueous detrital and marginal lacustrine (possibly "coastal") carbonates. Perseverance rover is exploring Jezero crater and preparing for future sample return. As such, the formation environment of carbonate in Jezero crater is important to understand with regard to astrobiological potential and biosignature preservation in rocks to maximize the scientific returns. These carbonate minerals also provide a ground truth of global fluviolacustrine carbonate on Mars. Here, we used CRISM data to map the band minimum of ($\lambda$ =) 2.3 μm features of Jezero crater to give new insights into the formation environment of marginal carbonate.

**Methods:** The latest calibration level CRISM image (Mapped Targeted Reduced Data Record) HRL000040FF are used to study the minerals in Jezero crater. Pre-calculated spectral parameters are also used to study specific spectral features of minerals [6]. We classified the pixels having D2300 value larger than 0.01 as the possible carbonate locations to conduct further analysis. Then, the continuum was removed for each selected possible carbonate pixel by calculation of a convex hull and removal it by division to acquire a normalization of the reflectance spectra to their continuum [7]. The wavelength position of the deepest absorption is determined by fitting a second order polynomial to spectra [8]. We assigned different wavelength position around 2.3 μm region as different color to map the variability of this absorption feature of marginal carbonate. Manual inspection was carried out to validate our automated mapping results.

**Results:** The marginal carbonate of Jezero crater shows variability in the 2.3 μm absorption minima, which relates to the cation identity and crystal chemistry of the carbonates (i.e. variability in the 2.3 mm absorption indicates variability in relative proportions of $Mg^{2+}$, $Fe^{2+}$, $Ca^{2+}$ and possibly $Mn^{2+}$). Six classes, 16286 pixels in total, are used to map the wavelength, including 2.284 μm, 2.293 μm, 2.304 μm, 2.311 μm, 2.317 μm and 2.324 μm. Manual inspection of dozens of spots found that the wavelength position minimum is consistent with the classification result. The absorption minima of 2.3 μm region is dominant by 2.311 μm, which is consist of 57.9% pre-selected pixels. The second large group is the absorption minimum 2.317 μm, containing 25.1 % pixels. 5.6% pixels are classified as 2.304 μm group. Other groups accounted for a small percentage, most likely resulting from noise (Fig. 1g).

The mapping results shows the norther part marginal carbonate shows longer wavelength position, 2.317 μm, while the 2.311 μm is common in south (Fig. 1a). The 2.317 μm region shows weaker hydration features than the 2.311 μm area. The HiRISE images of these two regions shows different surface texture. The 2.311 μm unit exhibits smooth, relatively flat polygonal surface (Fig. 1b). In contrast, the surface of 2.317 class is relatively rough and ridged (Fig. 1c).

**Discussion:** Mapping wavelength position variability is interesting because we can estimate the spatial distribution of the carbonate's chemistry. The $MgCO_3$ typically has absorptions centered at 2.295-2.310 μm and 2.495-2.505 μm; $FeCO_3$ commonly shows 2.320-2.325 μm and 2.520-2.530 μm absorption features; The minimum wavelength position of $CaCO_3$ is characterized by 2.340-2.350 μm and 2.530 – 2.540 μm [9].

The spectral variability of southern 2.311 μm region and northern 2.317 μm region indicates the presence of (Fe,Mg)-carbonate solid solutions. [5, 10]. Although the 2.3 μm features alone are not unique to carbonates and shared with Fe/Mg-OH, the band depth ratio of 2.3μm to 2.5 μm shows similar trends and proportional changes, which allows distinction between carbonates and clay minerals, and supports the interpretation of multiple carbonate compositions.

The spatial distribution of wavelength positions provides additional insights into the origin of these carbonate. Higher Fe-contents are expected to precipitate first in an evaporative setting, and variations in carbonate chemistry could reflect different fluid chemistry and possibly evolution of the lake environment.

**Conclusion:** Our preliminary result demonstrates the power of band minimum mapping of CRISM data revealing crystal chemistry of carbonate at meter scale from orbit. Further statistical analysis of the watershed of Jezero crater and global fluviolacustrine carbonate could provide a clearer picture of the aqueous chemistry of carbonate on Mars.

**Acknowledgments:** All data are publicly available from Planetary Data System (PDS).

**References:** [1] Mangold, N., et al. (2021) *Science*, 374(6568): p. 711-717. [2] Goudge, T.A., et al. (2018) *Icarus*, 301: p. 58-75. [3] Horgan, B.H.N., et al. (2020) *Icarus*, 339: p. 34. [4] Ehlmann, B.L., et al. (2008) *Nature Geoscience*. 1(6): p. 355-358. [5] Tarnas, J.D., et al. (2021) *JGR-Planets*, 126(11).[6] Viviano-Beck, C.E., et al. (2014) *JGR-Planets*, 119(6): p. 1403-1431. [7] Clark, R.N. and T.L. Roush (1984) *JGR-Solid Earth*, 89(B7): p. 6329-6340. [8] van Ruitenbeek, F.J., et al. (2014) *Planetary and space science*, 101: p. 108-117.[9] Gaffey, S.J. (1987) *JGR-Solid Earth*, 92(B2): p. 1429-1440. [10] Zastrow, A.M. and T.D. Glotch (2021) *GRL*, 48(9): p. 10.

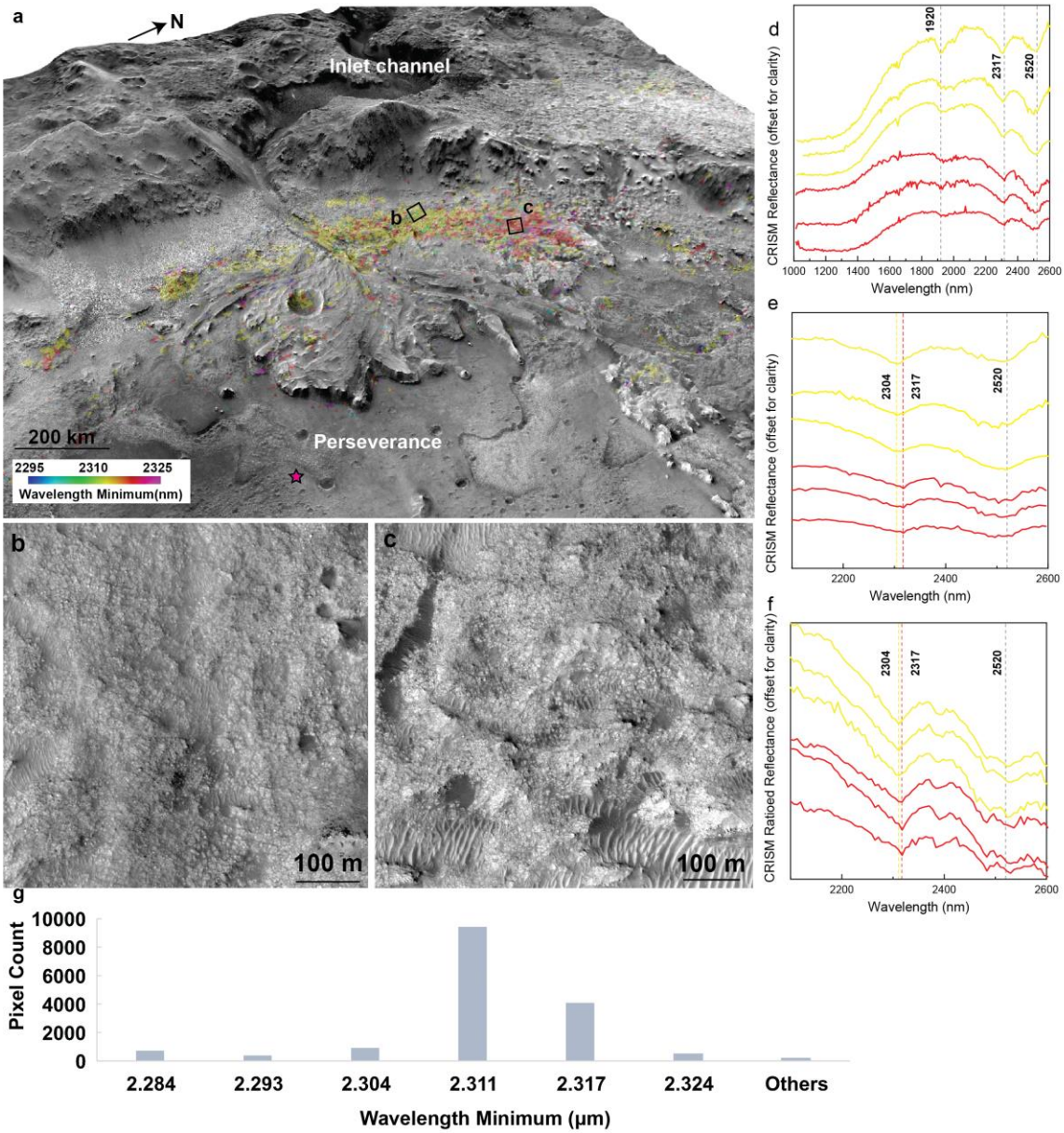


**Figure 1.** (a) Band minimum mapping of Jezero crater shows the spatial distribution of spectral variability of 2.3 μm features. Clouse-up view of surface texture of southern 2.311 μm region (b) and northern 2.317 μm region. (d) Extracted CRISM reflectance. The yellow lines indicate the spectra of 2.311 μm region and red lines show the spectra of 2.317 μm region. (e) Enlarged view of the CRISM reflectance. (f) CRISM ratioed reflectance. (g) The histogram of band minimum of carbonate unit.