POSSIBLE LACUSTRINE CARBONATES IN JEZERO CRATER, MARS – A CANDIDATE MARS 2020 LANDING SITE. B. Horgan[1] and R. B. Anderson[2]. [1]Purdue University, West Lafayette, IN (briony@purdue.edu), [2]U.S. Geological Survey, Astrogeology Science Center, Flagstaff, AZ.

Introduction: Jezero Crater (18.9°N 77.5°E) is one of the three finalist sites under consideration for the Mars 2020 rover mission and eventual sample return. Of particular interest in Jezero are the carbonate deposits that have been identified in and around the crater. "Mottled Terrain" has been mapped around the margin of Jezero and in the broader watershed, and is interpreted to contain Mg-carbonate and olivine [1-6]. The Light-Toned Floor unit appears to underlie the fan units and the "volcanic floor" unit, and grades into the surrounding Mottled Terrain. It also contains Mg-carbonate and olivine, and is often mantled by olivine-bearing aeolian bedforms [1,3]. Finally, the fan deposits also exhibit patches of carbonates in light-toned exposures interpreted as scroll bars. The strongest carbonate signatures in Jezero occur in a region in the NW inner margin of the crater, between the western delta deposit and the crater rim. We refer to these carbonate signatures as "marginal carbonates" but emphasize that this term is not meant to carry any connotations about their origin.

Here we present the results of a detailed investigation into the morphology and mineralogy of carbonates in and around Jezero to inform Mars 2020 landing site evaluation. We used the most recent CRISM MTRDR cubes [7] in conjunction with HiRISE to investigate the fine-scale morphology and CRISM spectral parameters of mapped units and unit boundaries.

Results: Based on our newly generated CRISM parameter maps, we find that the carbonate units within Jezero are more spectrally variable than previously reported (**Figure 1**). All of the carbonate-bearing units exhibit carbonate bands, hydration bands, and a mafic component, but the relative strengths of these parameters vary and correlate with morphology. Additionally, there appears to be a mafic signature that is distinct from olivine in many of the carbonates. The degree of hydration varies independently of carbonate band strength, indicating the presence of a distinct hydrated phase. We also detect silica or Al-clay bands in both fan deposits and in the "marginal" carbonates.

Mottled Terrain (MT): The MT unit is primarily characterized by an erosional texture of numerous small (10s to 100s of meters) ridges, often with a NE/SW orientation (**Figure 2**). These ridges are responsible for the mottled appearance at CTX scales. At finer scales, the MT is generally fractured with a highly variable texture. Some areas exhibit relatively smooth surfaces with fractures traceable for 100s of meters, other areas have smaller-scale polygonal or "honeycomb" fracture patterns, and other locations have rubbly surfaces. In general, the sub-unit designations from [3] are unclear at HiRISE scale, and may be misnamed (e.g. some "dusty MT" areas are clean exposures of bedrock with high thermal inertia inconsistent with dust cover). The spectral properties of the MT are likewise variable. The main spectral characteristic of the MT is strong hydration bands, often along with weaker carbonate and olivine bands than other carbonate units. However, some large regions of the MT within the crater do not exhibit carbonate bands and instead exhibit Fe/Mg-smectite bands, which is more consistent with exposed basement.

Fans and Deltas: There are three deposits in Jezero that have been mapped as fans or deltas. We refer to the farthest west and best-known of these as the "western delta". It is dominated by low-calcium pyroxene (LCP)

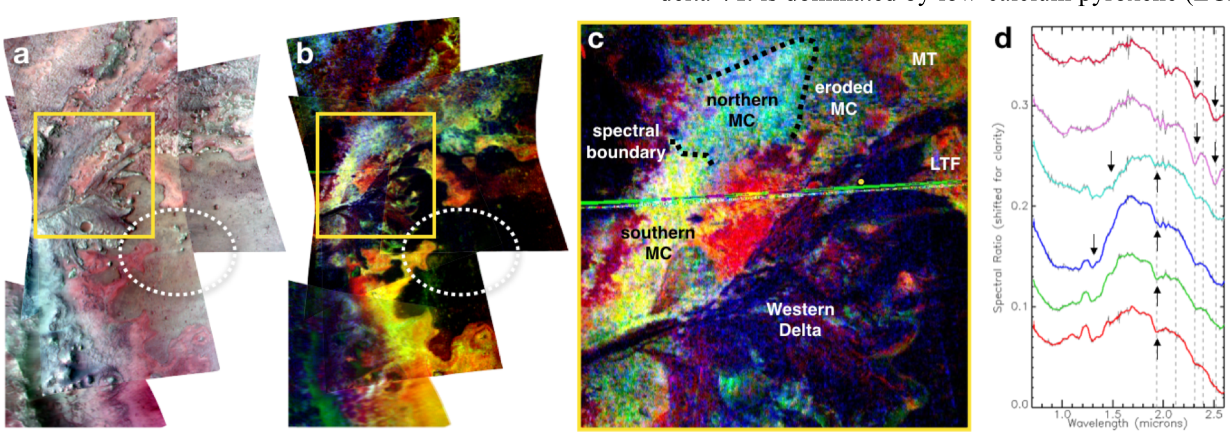

Figure 1: *Mosaic of CRISM maps. (a) False color RGB composite, R2529/R1330/R770. (b) Spectral parameter RGB composite, BD1300/BDI1000IR/MIN2345_2537 showing spectral diversity within the carbonate units. Red indicates olivine, green indicates mafic/hydrated component, and blue indicates carbonates. (c) Variability within the "marginal" carbonates (MC). (d) Spectra from CRISM cube FRT000047A3 showing differences between MC, mottled terrain (MT), and light toned floor (LTF).*

signatures in CRISM, and otherwise has variable mineralogy, exhibiting signatures of Fe/Mg-smectite, silica, hydration, and carbonates. A similar combination of LCP, strong hydration, and patchy alteration phases is observed in the "northeast fan". In contrast, the "northern fan" that lies in between the other two has a distinct mineralogy dominated by olivine, carbonate, and silica.

Light-toned floor (LTF): The LTF generally lacks the larger ridges and fractures characteristic of the MT. The LTF often has a characteristic "pock-marked" texture but elsewhere is smoother. The boundary between the LTF and the MT is often unclear, though in rare cases a contact can be identified. In some areas, such as the northern portion of the crater, the LTF does exhibit faint ridges similar to those observed in the neighboring MT. Spectrally, the LTF has strong olivine signatures that correlate with aeolian cover. The olivine-bearing sand appears to be sourced from the LTF itself, though there may also be a source of olivine to the east, indicated by an olivine-bearing wind streak east of the LTF.

"Marginal" carbonates (MC): These carbonates are distinct from other carbonate detections in and around Jezero. They are restricted to the base of the crater wall between -2300 and -2400 m, in the west and northwestern portions of the crater, and have stronger carbonate signatures than other units. The MC lacks the characteristic erosional texture of the MT, appearing smooth at CTX scale and heavily fractured and blocky at HiRISE scale. The MC can be divided into three sub-units based on spectral and morphological boundaries. The main MC unit near the inlet channel has uniformly strong carbonate signatures, clear hydration, and variable olivine, and may also be a source of olivine-bearing sands. To the northeast, there is a spectral transition in which the hydration and olivine signatures become weaker, but there is no clear morphological boundary. The far NE extent of the MC transitions to what may be a more eroded subunit. This boundary is apparent in both morphology and mineralogy, exhibiting a smoother fractured texture at HiRISE scales and weaker spectral signatures similar to the more northerly MC.

The MC is morphologically distinct from the LTF, lacking the "pock-marked" texture characteristic of the LTF in the NW crater floor. The "eroded" MC is rough at larger scales and in some locations is morphologically similar to the MT (yet spectrally distinct). Although the most distinct exposure of the MC is to the NW of the W delta deposit, outcrops with similar spectral signatures and similar textures occur along the base of much of the western crater rim.

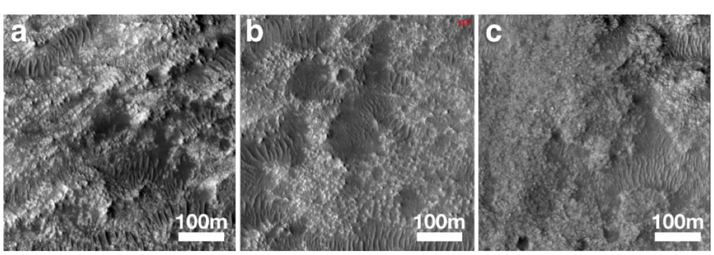

Figure 2: *Typical morphologies for carbonate units within Jezero crater. (a) Ridges of the Mottled Terrain, (b) "pockmarked" texture of the Light-Toned Floor, (c) rough and blocky texture of the "marginal" carbonates.*

Conclusions: All the units discussed here post-date the period of significant erosion in Jezero, because the MT drapes the eroded northern rim. The MT is variable but it does appear to be similar inside and outside the crater. One hypothesis for the origin of such an extensive unit is that it is a tephra deposit [8], possibly similar to Algonquin observed at Gusev. The LTF may be a sub-unit of the MT, possibly resulting from aeolian reworking of the MT tephra to concentrate olivine sands in the crater. It could alternatively be a lacustrine deposit, though in is unclear why a lacustrine deposit would be a source of olivine sand.

The three fans/deltas are on top of the MT and therefore postdate it. The W delta appears to have been eroded back significantly, but has not been degraded to the extent of the N and NE fans. This is not due to mineralogy [3], as the NE fan has a similar mineralogy to the W delta. Thus, the W delta may be younger than the N/NE fans. The N/NE fans may have been part of one larger fan, or two separate deposits.

The most intriguing new result from this study is the distinctive mineralogy and morphology of the MC. The MC could be a sub-unit of the MT or the LTF, with differences in mineralogy and morphology resulting from the influence of the crater rim on circulating fluids. Alternatively, the restricted elevation of the MC (-2300 to -2400) is comparable to the upper stand (-2260 m) and minimum elevation (-2395 m) for a Jezero paleolake reported by [9], suggesting that the MC could be associated with the paleolake margins.

If the MC are shoreline deposits, they would be a high priority target for Mars 2020 and Mars Sample Return, as near-shore carbonate deposits on Earth are commonly biologically mediated (e.g., carbonate reefs, stromatolites, and microbialites), and have high biosignature preservation potential [10]. However, additional work is required to test this hypothesis against the properties of terrestrial lacustrine carbonates.

References: [1] Ehlmann et al. (2008) *Nat Geo 1*, 355-358. [2] Goudge et al. (2012) *Icarus 219*, 211-229. [3] Goudge et al. (2015) *JGR 120*, 775-808. [4] Goudge et al. (2017) *EPSL 458*, 357-365. [5] Brown et al. (2016) LPSC 47, #2165. [6] Brown et al (2017) LPSC 48, #2346. [7] Seelos et al. (2016) LPSC 47, #1783. [8] Bramble et al (2017) Icarus 293, 1-28. [9] Fassett et al. (2005) GRL, 32, L14201. [10] Grotzinger & Knoll (1999) *An. Rev. EPS 27, 313-358.*