CARBONATE MINERALOGY OF THE JEZERO CRATER WATERSHED. A.J. Brown[1], C.E. Viviano-Beck[2], T.A. Goudge[3], K.D. Putirka[4]. [1]SETI Institute, 189 N. Bernardo Ave, Mountain View, CA (abrown@seti.org) [2]Johns Hopkins Applied Physics Laboratory, MD [3]Jackson School of Geosciences, University of Texas, Austin, TX, [4]Earth and Environmental Sciences, CSU Fresno, CA.

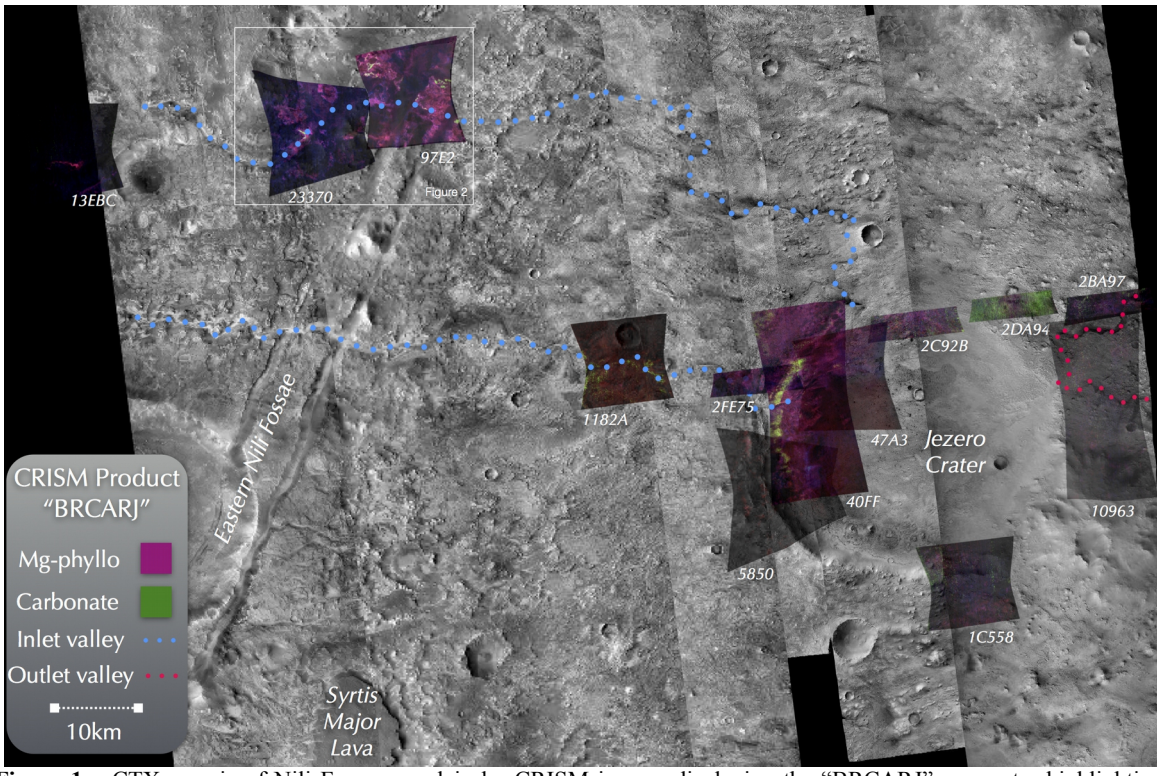

Figure 1 – CTX mosaic of Nili Fossae overlain by CRISM images displaying the "BRCARJ" parameter highlighting presence of carbonate and Mg-phyllosilicate in watershed surrounding Jezero crater. Inset shows location of Figure 2. Inlet valleys for west and northern deltas are indicated. Image projections/map creation using "MR PRISM" software suite.

Introduction: The Nili Fossae region is the site of a number of proposed Landing Sites for the Mars 2020 Rover. A distinguishing feature of most of these sites is the access to relatively large exposures of carbonate [1]. Smaller carbonate deposits have been found and mapped elsewhere on Mars [2,3,4].

Jezero Crater: Amongst the sites of interest in the Nili Fossae region is the paleolake basin contained within the ~45 km diameter Jezero impact crater. The Jezero crater paleolake is classified as hydrologically open, and is fed by two inlet valleys to the north and west, and drained by an outlet valley to the east (Fig. 1) [5]. Buffered crater counts of the fluvial valleys associated with the Jezero paleolake indicate that this system ceased activity by approximately the Noachian-Hesperian boundary at 3.7 Ga, similar to the timing of other large valley network systems on Mars [6].

Jezero crater is highly appealing as a potential landing site for the Mars 2020 Rover as it contains two well-exposed fluvio-lacustrine delta deposits [5,6,7] in addition to large exposures of both phyllosilicate minerals and carbonates [5], meaning it can provide details of both the fluvial sedimentary record and aqueous alteration history of early Mars.

Rationale and Science Hypothesis: The so-called "talc-carbonate" hypothesis [8] rests on the presence of a 2.38µm absorption band that is almost always present in Nili Fossae when carbonate absorption bands are detected. It is hypothesized that because the carbonate 2.54µm feature is so often accompanied by a 2.38µm band, there may be a geophysical link between the Mg-phyllosilicate causing the 2.38µm band and the accompanying Mg-carbonate [8]. We have therefore conducted a study of the spatial occurrence patterns of the 2.38µm band in the Jezero crater and watershed.

The overall aim of this study is to test our hypotheis by addressing the following **three science questions**:

1.) Is there a continuous spatial gradient in the strength of the 2.38µm band material in the Jezero watershed, or more of a step function? 2.) How does the 2.38µm occurrence pattern correlate to previously recognized geological units? 3.) Does any 2.38µm band material outcrop in the Jezero crater that might be accessible to a landed Mars2020 rover?

Take-away message: Our mapping of the watershed region and the Jezero delta has revealed that the strong carbonate signatures within Jezero crater display weak to absent 2.38µm bearing material, but there is a key region in the Jezero northern fan watershed (Fig. 2) that shows evidence of 2.38µm band material.

Methods: We have used CTX images, CRISM FRT, FRS and HRL image BRCARJ browse products and spectral feature fitting to discriminate between 2.38µm-bearing material and Mg-carbonate that lacks the 2.38µm band. The BRCARJ browse product highlights carbonate (in green in our Figures) by identification of a 2.54 and 2.3µm absorption band [9].

Results: Fig. 1 shows CRISM BRCARJ FRT and HRL images overlaying a CTX image of the Jezero delta watershed, projected and rectified in the MR PRISM software suite, and shows the north and western input valleys, largely in agreement with those mapped by Goudge et al. [5].

Fig. 2 shows two FRT images in the northern delta watershed that are relatively rich in 2.38µm band material, in contrast to carbonates outcropping within the crater. This fact may require different formation mechanisms for the carbonate units in the watershed and those in the crater and explaining this spectral contrast is one of our guiding science goals.

Our focus continues to move towards higher resolution observations of smaller outcrops to address our three science questions, including recently acquired FRS images (e.g. 2DA94 and 2BA97 in Fig. 1) which show previously unrecognized carbonate outcrops close to the Jezero rim outlet valley.

Serpentinization hypothesis: Serpentinization has been proposed as a formation mechanism of the Nili Fossae carbonates, including carbonated [8,10] and low temperature, near surface serpentinization [8,12]. Motivated by fieldwork in the Pilbara region of Western Australia [13] Brown et al. proposed that talc-carbonate serpentinization was a good candidate to explain spectral signatures of Nili Fossae carbonates [8]. Recent studies have uncovered corroborating spectral evidence for talc in association with the carbonate at Nili Fossae using the CRISM spectrometer on MRO [9]. If Mars2020 is able to identify the 2.38µm band material in association with altered olivine as part of a volcanic package, then this will help address several key questions regarding the geological history of Mars.

Volcanic olivine and Early thermal history of Mars: One such question is whether Mars ever exhibited plate tectonics, with spreading ridges and subduction zones, as on Earth, or whether the outer lithosphere always acted as a single plate – a "stagnant lid" [14]. Should Mars2020 find and investigate all or part of a putative early Martian volcanic package, we can make use of the olivine normative mineralogy within this sequence to estimate subsurface mantle temperatures at 3.9 Ga, and so test models of plate tectonic and planetary cooling regimes [14]. This makes Jezero Crater and all the Nili Fossae landing sites particularly compelling as candidate Mars2020 landing sites [15].

Acknowledgements: This work was sponsored by the NASA Astrobiology Institute.

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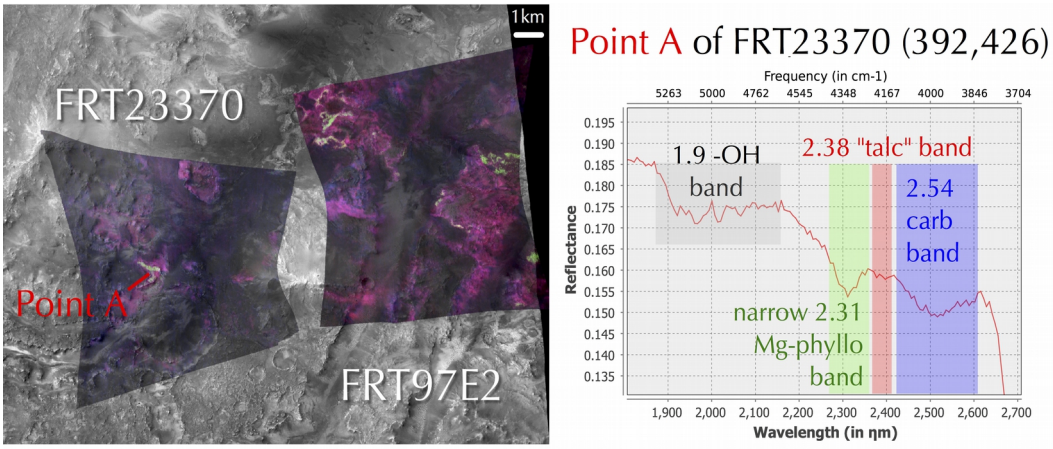

Figure 2 - (left) CRISM FRT23370 and FRT 97E2 overlain on CTX image. As for Fig. 1, the BRCARJ browse images are green in the presence of a 2.54µm band [9]. These carb locations all have accompanying 2.38µm bands as seen on (right) spectra from FRT 23370 showing 2.31 and 2.38µm bands with a broad 2.54µm band due to Mg-carbonate. No ratioing has been conducted on these spectra. See Fig. 1 for context.