HYDRATED SILICA IN THE JEZERO DELTAS. J.D. Tarnas[1], J.F. Mustard[1], H. Lin[2], T.A. Goudge[3], E.S. Amador[4], M.S. Bramble[1], X. Zhang[5], [1]Brown University Department of Earth, Environmental and Planetary Sciences, [2]Institute of Geology and Geophysics, Chinese Academy of Sciences, [3]The University of Texas at Austin, Jackson School of Geosciences, [4]California Institute of Technology, Division of Geological and Planetary Sciences, [5]Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences.

Introduction: Hydrated silica has been detected on Mars in near-infrared reflectance spectra [1-5], in thermal emission spectra [6], by Spirit in Gusev crater [7,8], and by Curiosity in Gale crater [9]. Hydrated silica forms in a variety of temperature and pH conditions [10] and by itself is not diagnostic of any specific geochemical environment. However, an assemblage of minerals associated with hydrated silica can place constraints on the geochemical environment of precipitation. For example, during aqueous alteration of basalt, hydrated silica forms along with kaolinite in acidic hydrothermal systems and through leaching [11], and it forms along with carbonate in neutral-alkaline hydrothermal systems containing high concentrations of dissolved CO_2 [12]. It is precipitated as an alteration rind on basalt in a volcano-fumarole environment [13] and is also precipitated in lacustrine settings [14]. Hydrated silica is a key mineral of interest for the Mars 2020 rover mission due to its high potential for biosignature preservation [e.g. 15]. It can also be used to gauge the extent of water-rock interaction, as it transitions from amorphous (opal-A) to more crystalline silica (opal-CT, opal-C, chalcedony) upon prolonged exposure to an aqueous environment [2]. Jezero crater, the future landing site of the Mars 2020 rover, is known to have hosted a lake fed by two inlet rivers and drained by one outlet river and currently hosts the remnants of two deltas, of which the western is better preserved [16].

Methods: We have detected hydrated silica in the western Jezero delta and surrounding regions using Dynamic Aperture Factor Analysis/Target Transformation (DAFA/TT) [17]. Factor analysis and target transformation (FATT) have previously been applied to TES [18,19], Mini-TES [20,21], OMEGA [22], and CRISM [23,24] data. Factor analysis determines the number of independently varying spectral components from a given set of spectra [25]. Target transformation produces linear combinations of significant eigenvectors to fit library spectra of specific minerals [23,24,25] (Figure 1). This allows for detection of spectrally active compounds (e.g. minerals) at low abundances and in complex convolutions [e.g. 23, 24].

Previous applications to CRISM data performed FATT using all pixels in a given CRISM scene [23,24]. This detects minerals present across the scene in low abundances and complex convolutions, but does not preserve information regarding the spatial location of the detected mineral. DAFA/TT performs FATT on small clusters of ~50 pixels in CRISM images, comparing target transformation fits to library spectra of minerals. The clusters of pixels used move across the CRISM image one pixel at a time, performing FATT on each iteration. FATT is applied to pixel clusters of different geometries (squares, rectangles) and only pixels with positive detections in all cluster geometries are accepted as true positives. This reduces false positive detections and helps to refine the spatial location of detections. Positive detections are defined as target transformation fits to library spectra with an RMSE $\leq 1.5 \times 10^{-4}$, an empirically determined value. Examples are shown in Figure 1.

We apply DAFA/TT to 8 standard CAT-processed CRISM images in Jezero crater, the surrounding Nili Fossae region, and the watershed for the Jezero lake to detect key minerals and in combination polymineralic assemblages. The assemblage analysis allows for more precise constraints on aqueous alteration environments than possible using interpretations of single mineral detections [4]. We include kaolinite, Fe/Mg-smectites, Ca/Mg/Fe-carbonates, serpentine, chlorite, talc, brucite, zeolites, illite, muscovite, hydrated silica, epidote, and a variety of hydrated and nonhydrated Fe/Mg/Ca-sulfates in our spectral library.

Results: We detect hydrated silica in multiple locations within the western Jezero delta and in one location in the northern Jezero delta (Fig. 1). Hydrated silica is associated with light-toned fractured features, light-toned layered deposits, and some dark-toned floor material between light-toned layered deposits.

We also detect hydrated silica in the surrounding region, which hosts the source rock for the sediment that composes the Jezero delta. We detect this hydrated silica in association with magnesite within the olivine-rich fractured unit [4], and associated with jarosite and monohydrated sulfate within different locations of this same unit. We also detect hydrated silica associated with a kaolin-group mineral in the basement unit and isolated hydrated silica detections in basement mounds [26].

Discussion & Conclusions: These different hydrated silica formation environments likely represent a range of formation conditions, from acidic hydrothermal conditions associated with the hydrated silica-jarosite-monohydrated sulfate assemblage, to neutral-alkaline hydrothermal conditions associated with the hydrated silica-magnesite assemblage, to hydrothermal or leaching systems associated with the hydrated silica-kaolin group assemblage. Hydrated silica is associated with these assemblages and others within ridge networks [17,27], which may be mineralized fracture planes more resistant to erosion [27]. It is also often associated with light-toned material, as has been noted elsewhere on Mars [1,2].

Hydrated silica detected by DAFA/TT in the Jezero deltas is either authigenic or detrital, or some combination of both. If it is authigenic, *(i)* it formed during deposition of the sediment comprising the Jezero deltas, *(ii)* or via precipitation in the lake water column, *(iii)* or via a later diagenetic event as seen in Gale crater [9]. Precipitation environments *i & ii* would be highly favorable for preserving biosignatures if life did inhabit Jezero crater's lake during the Noachian. If the hydrated silica in the Jezero deltas is detrital in origin, the favorability of biosignatures preserved in this high-biosignature-preservation-potential material is highly dependent on the habitability of the environment where the silica was precipitated.

Both acidic and neutral-alkaline hydrothermal systems are known to host life [28, 29], though neutral-alkaline aqueous conditions are generally considered more favorable for biology than highly acidic conditions. Detrital hydrated silica within the Jezero deltas associated with jarosite and other sulfates may be a less favorable target for astrobiological investigation than detrital hydrated silica associated with carbonate. Hydrated silica detected within these deltas represents a prime target for astrobiological investigation with the Mars 2020 rover.

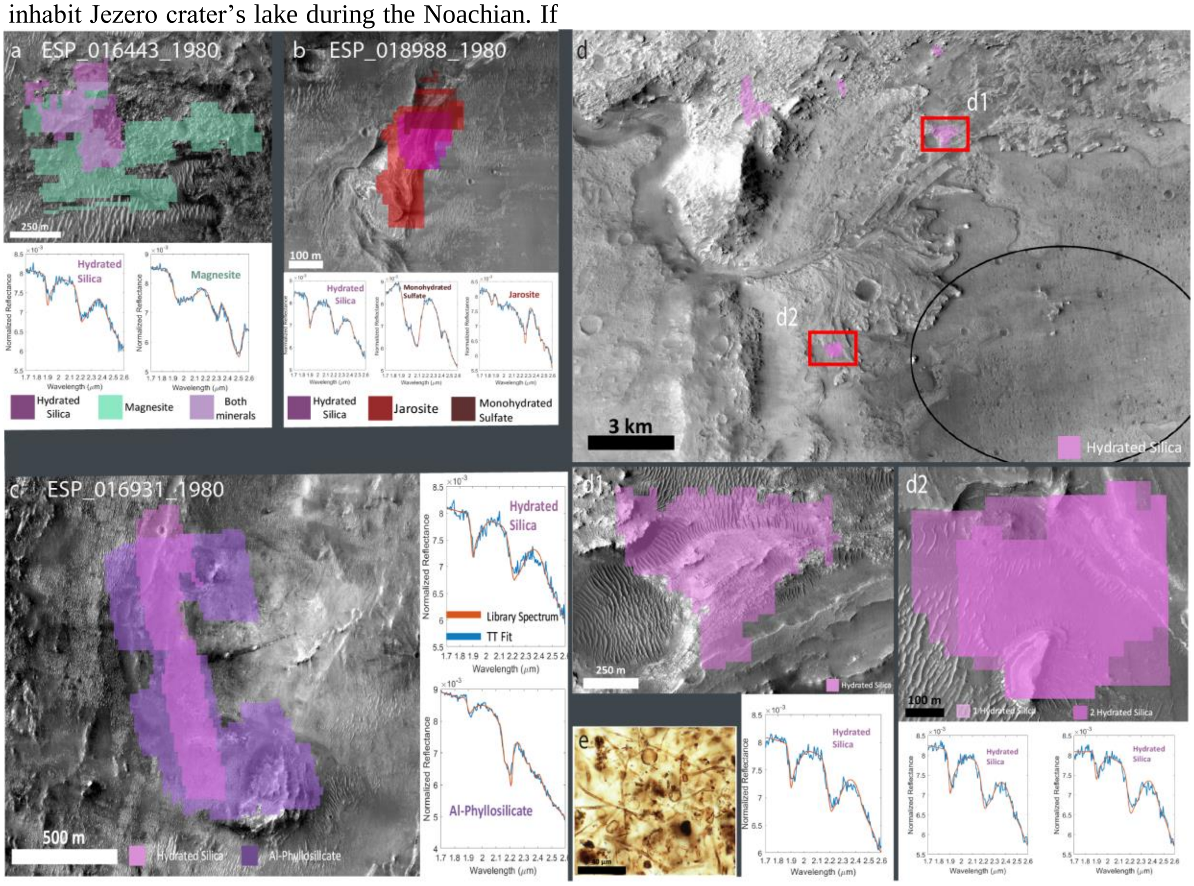

Figure 1 | Hydrated silica in Jezero deltas and surrounding region. a) Hydrated silica and hydromagnesite detections within the olivine-rich fractured unit. b) Hydrated silica, jarosite, and monohydrated sulfate detections within the olivine-rich fractured unit. c) Hydrated silica and kaolin-group mineral detections within the basement unit. d) Hydrated silica detections in the western Jezero delta. e) Microfossils preserved in chert on Earth (image from [15]).

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