SEDIMENTOLOGY OF THE JEZERO CRATER WESTERN FAN DEPOSIT: 1. EVIDENCE FOR A DELTAIC ORIGIN AND IMPLICATIONS FOR FUTURE EXPLORATION.

T. A. Goudge[1], R. E. Milliken[2], J. W. Head[2], J. F. Mustard[2], and C. I. Fassett[3], [1]Jackson School of Geosciences, The University of Texas at Austin, Austin, TX, [2]Dept. of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI, [3]Dept. of Astronomy, Mount Holyoke College, South Hadley, MA. (Contact: tgoudge@jsg.utexas.edu)

Introduction: Fan deposits within the Jezero crater open-basin lake on Mars have been interpreted as deltas on the basis of their geologic setting and exposed distributary channels [e.g., *1-3*]; however, this hypothesis has yet to be tested using observations of exposed stratal geometries. Here we present observations of the stratigraphic architecture and mineralogy of the western fan deposit (**Fig. 1**), to help constrain the depositional environment (e.g., deltaic vs. alluvial fan) of this deposit.

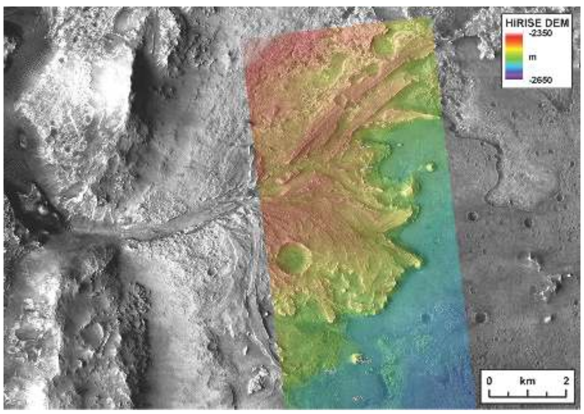

Fig. 1: *Overview of the Jezero crater western fan deposit. HiRISE-derived DEM from images PSP_003798_1985 and PSP_002387_1985 overlain on a mosaic of HiRISE image PSP_003798_1985 and CTX image P04_002664_1988.*

Methods: We investigated the exposed sedimentary structures of the western fan deposit using a high-resolution digital elevation model (DEM) and orthorectified image derived from HiRISE images [*4*] using the NASA Ames Stereo Pipeline (ASP) [*5-7*].

Exposed strata were identified and mapped as differentially eroded units that protrude from the surrounding material or form clear topographic benches (e.g., **Fig. 2**), similar to other examples of mapped bedding in martian sedimentary deposits [e.g., *8-10*]. Strata that are laterally contiguous over >50 m were mapped, and location information (in three dimensions) at ~5 m intervals was used to calculate strike and dip from planes fit using a linear least squares method [e.g., *8-10*].

The mineralogy of the fan deposit was investigated using a targeted CRISM [*11*] image over the fan deposit alongside co-registered images and topographic data to determine the context and stratigraphic position of identified mineral phases. CRISM data analysis was guided by spectral parameter maps [*12-14*].

Results: We mapped 24 exposed layers within the fan, which all dip approximately towards the basin depocenter (**Fig. 2A**). Dips range from ~0.5-9° and there is a clear trend of increasing layer dip with increasing elevation along the eroded front of the fan (**Fig. 2C**). We also identify several locations where exposed layers downlap onto underlying strata (**Fig. 2B**).

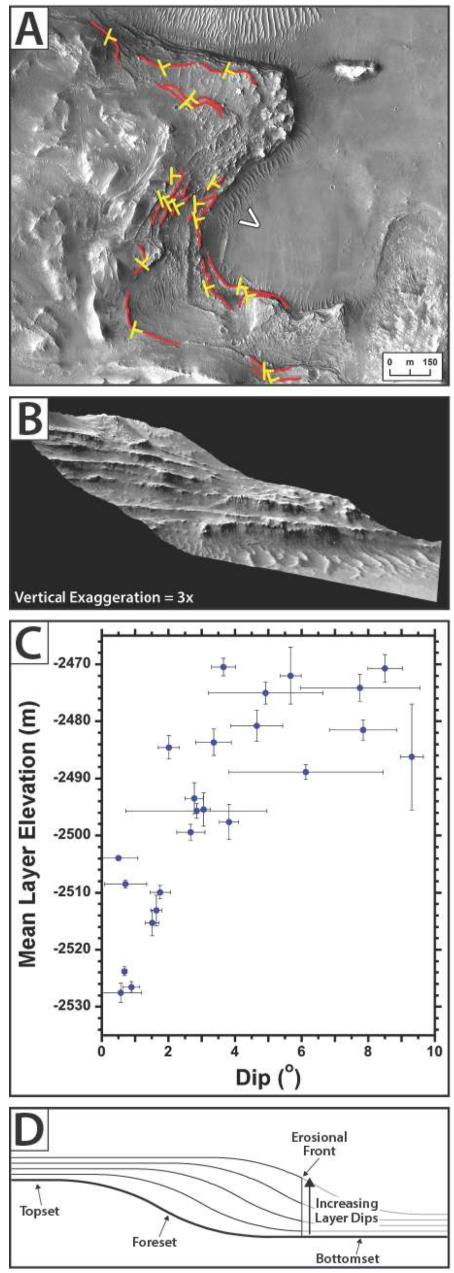

Fig. 2: ***(A)*** *Exposed layering within the Jezero crater western fan deposit. Red lines show mapped layers, with corresponding strike and dip directions (yellow symbols). HiRISE image PSP_003798_1985. White '<' symbol shows the approximate look direction for part (B).* ***(B)*** *Perspective view of the ex-*

posed layering in part (A). HiRISE image PSP_003798_1985 draped over a HiRISE-derived DEM from images PSP_003798_1985 and PSP_002387_1985. ***(C)*** *Mean layer elevation versus dip for mapped layers. Error bars are 1σ on elevation values along the layer, and 95% confidence limits on dip from the linear least squares plane misfit.* ***(D)*** *Idealized sketch of clinoforms within a prograding delta showing the expected trend of increasing layer dip with increasing elevation along an erosional front of the deposit.*

We identify strong Fe/Mg-smectite signatures in the deposit's lower stratigraphic units, and Mg-rich carbonate in a few isolated locations in stratigraphically higher light-toned materials (**Fig. 3**) interpreted to be fluvial channel point bar deposits [*3*]. These spectral identifications are consistent with previous analyses of the mineralogy of this fan deposit [e.g., *2,13,15,16*].

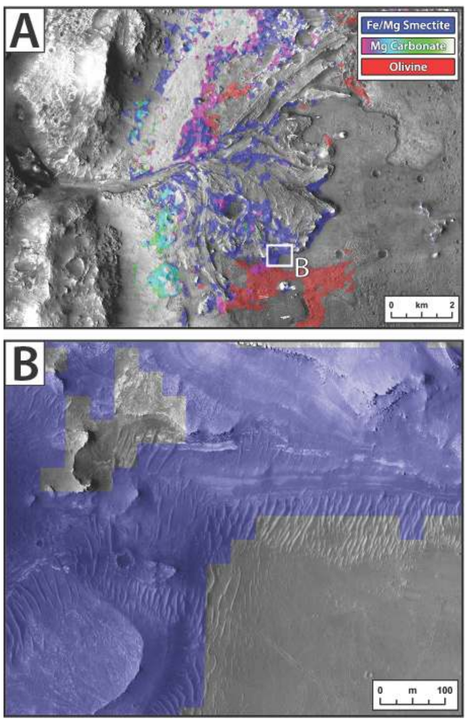

Fig. 3: ***(A)*** *CRISM parameter map of the Jezero crater western fan deposit, where R = OLINDEX2 [14], G = BD2500 [13], and B = D2300 [12]. Interpretive legend shown in upper right corner. Location of (B) is shown by white box. Parameter map from CRISM image HRL000040FF overlain on a mosaic of HiRISE image PSP_003798_1985 and CTX image P04_002664_1988.* ***(B)*** *Example Fe/Mg-smectite detection within the stratigraphically lowest units of the fan deposit. Image shows the same CRISM parameter map as in part (A) overlain on HiRISE image PSP_003798_1985.*

Discussion: Downlapping stratal geometries (e.g., **Fig. 2B**) are consistent with layer terminations in the distal portions of deltaic clinoforms and are common in delta deposits on Earth [*17,18*]. The trend in layer dip versus elevation (**Fig. 2C**) is also consistent with the expected trend along the erosional front of a prograding delta (**Fig. 2D**). We interpret the more steeply dipping (>~2°), downlapping strata as foresets and the underlying, shallowly dipping (<~2°) strata as bottomsets.

The spatial distribution of minerals in the Jezero crater western fan deposit is also consistent with a deltaic origin. Of particular importance is the identification of strong signatures of Fe/Mg-smectite, likely a detrital clay mineral in this system [*2,13,16*], in the stratigraphically lowest units of the fan deposit that we interpret as the delta bottomsets (**Fig. 3**). This observation is consistent with terrestrial facies models of delta deposits in which fine-grained materials transported in suspension, such as clay minerals, are concentrated in bottomsets in the most distal margins of the delta [*17,19*].

Conclusions: Based on both the stratigraphic architecture and mineralogy of the Jezero crater western fan deposit, we conclude that this deposit is deltaic in origin. The delta formed during the era of valley network incision on Mars, when the Jezero crater paleolake was active [*1,20*] and when rates of surface runoff compared with evaporation were sufficiently high to sustain a standing body of water within the basin.

Implications for Future Exploration: Our observations of Fe/Mg-smectite-rich deltaic bottomsets (**Figs. 2,3**) that would be accessible to a rover make the Jezero crater paleolake basin a compelling site for future *in situ* exploration, such as by the upcoming Mars 2020 rover [*21*]. Quiescent depositional environments dominated by fine-grained sedimentation, such as deltaic bottomsets, have a high concentration and preservation potential for organic matter [e.g., *17,22*], making them attractive locations for *in situ* exploration on Mars [*23*]. Additionally, the presence of Fe/Mg-smectite within the delta deposit, and particularly within the bottomsets of the deposit (**Fig. 3**), is of further importance [*2*] as clay minerals have the ability to bind organic matter [e.g., *24*]. Therefore, we suggest that the remarkably well-preserved stratigraphy of the Jezero crater western delta deposit make this site a prime candidate for *in situ* exploration by future landed missions to Mars.

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