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Provenance and Diagenesis of Martian Sedimentary Rocks in the Jezero Crater Delta Front from Microscale Observations by the Mars 2020 PIXL Instrument

JOEL HUROWITZ[1], MICHAEL M. TICE[2], ABIGAIL ALLWOOD[3], MORGAN CABLE[3], TANJA BOSAK[4], ADRIAN BROZ[5], GWÉNAËL CARAVACA[6], BEN C. CLARK[7], ERWIN DEHOUCK[8], ALBERTO G FAIREN[9], FELIPE GOMEZ[10], JOHN P. GROTZINGER[11], SANJEEV GUPTA[12], JEFFREY R JOHNSON[13], LINDA C. KAH[14], HEMANI KALUCHA[11], JOSH LABRIE[15], AN Y LI[16], LUCIA MANDON[11], JORGE NÚÑEZ[13], DAVID ARGE KLEVANG PEDERSEN[17], FRANCOIS POULET[18], NICOLAS RANDAZZO[19], EVA L SCHELLER[4], MARIEK SCHMIDT[15], DAVID L. SHUSTER[20], KIRSTEN SIEBACH[21], SANDRA SILJESTRÖM[22], JUSTIN I. SIMON[23], NICHOLAS J. TOSCA[24], ALLAN TREIMAN[25], SCOTT J VANBOMMEL[26], LAWRENCE A WADE[3], KENNETH H WILLIFORD[27] AND ANASTASIA YANCHILINA[28]

[1]Stony Brook University
[2]Texas A&M University
[3]NASA-Jet Propulsion Laboratory
[4]Massachusetts Institute of Technology
[5]University Oregon
[6]IRAP
[7]Space Science Institute
[8]LGL-TPE (Univ. Lyon 1 / CNRS)
[9]Cornell University
[10]Centro De Astrobiologia
[11]California Institute of Technology
[12]Imperial College London
[13]JHU APL
[14]University of Tennessee
[15]Brock University
[16]University of Washington
[17]Technical University of Denmark
[18]Universite Paris Saclay
[19]University of Alberta
[20]University of California, Berkeley
[21]Rice University
[22]RISE Research Institutes of Sweden
[23]NASA Johnson Space Center
[24]University of Cambridge
[25]Lunar and Planetary Institute
[26]Washington University in Saint Louis
[27]Blue Marble Space Science Institute
[28]Impossible Sensing, LLC.

Presenting Author: joel.hurowitz@stonybrook.edu

On ~sol 370 of the *Perseverance* rover mission, the Mars 2020 Science Team completed its investigation of igneous units of the Jezero crater floor [1] and directed *Perseverance* to drive towards the topographic scarp that marks the interface between the crater floor and Jezero's western delta. The "Delta Front Campaign" consisted of close-up investigation and sampling of lithologies located there.

Here, we report on the major findings relevant to the provenance and diagenetic history of these lithologies deduced from measurements made by the Planetary Instrument for X-ray Lithochemistry (PIXL), a micro-focus X-ray fluorescence (XRF) microscope [2]. Data were collected from the Shenandoah formation at two stratigraphic sections: Cape Nukshak and Hawksbill Gap [3].

Sediment provenance ranges from relatively homogeneous, altered olivine-dominated sources at the base of the section at Cape Nukshak in the Amalik member, to highly heterogeneous and altered (likely serpentinized) mafic to ultramafic sources at the top of the section at Hawksbill Gap in the Rockytop member. The presence of Fe-bearing carbonate at both locations indicates precipitation from anoxic, alkaline waters of moderate pH. The Yori Pass member (Cape Nukshak), and the Hogwallow Flats and Devils Tanyard members (Hawksbill Gap) contain abundant Fe-Mg sulfates and phyllosilicates, with compositions that indicate at least one period of deposition under anoxic, hypersaline conditions. The preservation of the Fe-Mg sulfate component of these rocks is remarkable, given its extreme solubility and susceptibility to oxidation. Fluids that precipitated later cross-cutting anhydrite apparently had little effect on rock bulk compositions. At present, it is uncertain whether observed evidence for oxidation, including ferric-sulfate, results from ~syn-depositional variability in atmospheric and aquatic redox state, or later diagenesis or weathering. A major finding of this investigation is that the Shenandoah formation contains compositionally and mineralogically diverse sedimentary rocks, which bodes well for sample return science, and indicates that paleo-environmental conditions were variable in space and/or time during delta deposition and diagenesis.

References: [1] Farley, K. et al. (2022) *Science, 377* [2] Allwood, A. et al. (2020) *Space Sci. Rev., 216* [3] Stack K. et al. *LPSC 2023.*