SPECTRAL DIVERSITY ALONG THE DELTA FRONT IN JEZERO CRATER, MARS AS SEEN WITH MASTCAM-Z ON THE MARS 2020 *PERSEVERANCE* ROVER. J. I. Núñez[1], J. R. Johnson[1], M. S. Rice[2], B. N. Horgan[3], A. Vaughan[4], B. J. Garczynski[3], L. E. Duflot[2], C. C. Million[5], M. St. Clair[5], M. Merusi[6], K. M. Kinch[6], A. G. Hayes[7], C. Tate[7], S. Gupta[8], R. Barnes[8], L.C. Kah[9], J. Maki[10], J. F. Bell III[11], K. C. Benison[12], A. Brown[13], J. Hurowitz[14], L. Mandon[15], P. Russell[16], and Mastcam-Z Team. [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723 (jorge.nunez@jhuapl.edu); [2]Western Washington Univ., Bellingham, WA; [3]Purdue Univ., South Bend, IN; [4]Apogee Engineering, Flagstaff, AZ; [5]Million Concepts; [6]Univ. of Copenhagen, Denmark; [7]Cornell Univ., Ithaca, NY; [8]Imperial College of London, UK; [9]Univ. of Tennessee, Knoxville TN; [10]JPL/Caltech, Pasadena, CA; [11]Arizona State Univ., Tempe, AZ; [12]W. Virginia Univ., Morgantown, WV; [13]Plancius Research, MD; [14]Stony Brook Univ., NY; [15]Caltech, Pasadena, CA; [16]UCLA, Los Angeles, CA.

Introduction: On February 18, 2021, NASA's Mars 2020 *Perseverance* rover landed on the floor of Jezero crater, a 45 km diameter Noachian-aged basin characterized by an ancient lake-delta system during the Late Noachian-Early Hesperian epochs on Mars [1-2]. The deposits of the western delta are considered high-priority targets for investigation by *Perseverance* as they may preserve a record of an early habitable environment and potential biosignatures.

After investigating and collecting samples from the Máaz and Séítah formations on the crater floor [3], *Perseverance* arrived at the delta front in April 2022 and investigated the sedimentary deposits at the "Cape Nukshak" (CN) and "Hawksbill Gap" (HBG) areas [4-5]. The Mastcam-Z instrument [6] on the *Perseverance* rover has provided near-field and long-distance imaging of the delta front, and is used to characterize the diversity of morphologies, textures, surface coatings, colors, and spectral properties of rocks and soils along the rover traverse. Here we use Mastcam-Z images and multispectral observations over a range of scales, from close-up observations of abraded patches and rock faces, to outcrop and landscape observations to characterize the stratigraphy, spectral diversity and mineralogy of the rocks and facies within the delta front.

Mastcam-Z Instrument: Mastcam-Z is a multispectral, stereoscopic, dual imaging system composed of two zoom cameras mounted on the Remote Sensing Mast of the rover [6]. Its two "eyes" generate high-resolution color wide-angled and zoomed-in images (focal lengths ranging from 26 mm to 110 mm) of close and distant targets. Each camera has a FOV from ~5° to ~23° along longest axis (IFOV from 67 to 283 µrad/pix) and 3 broadband RGB and 6 narrowband filters, spanning the Visible and Near-Infrared wavelengths (442-1022nm). Mastcam-Z observations are calibrated to I/F and spectra are converted to reflectance factor (*R**) [7-8]. Spectral parameters are used to detect and map olivine, pyroxene, and oxide mineral signatures such as hematite across the landscape and rock surfaces [9].

Spectral Diversity Along the Delta: Mastcam-Z multispectral observations of surfaces along the delta front show spectral signatures that are due to a combination of dust, coatings, regolith, and rock surfaces. Multispectral observations of the delta front reveal mineral diversity among different facies of the delta fan (Fig. 1). Spectra with absorptions at 900 nm and negative slope towards 1000 nm, consistent with low-Ca pyroxene (LCP) and olivine respectively, are

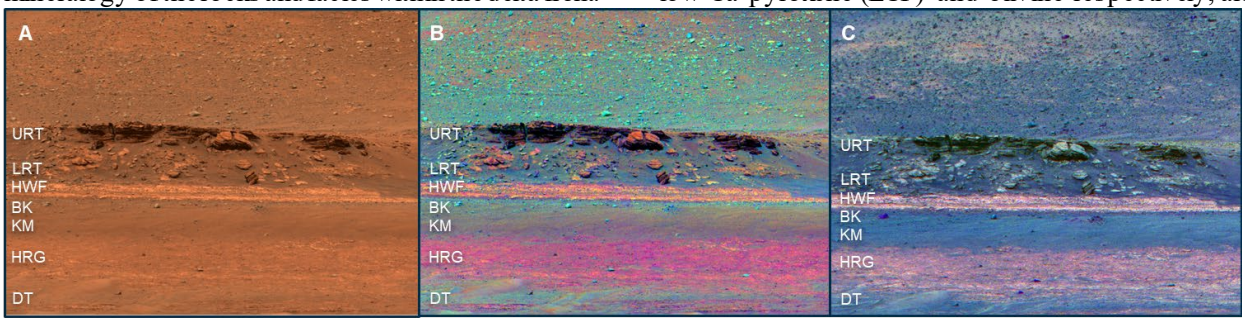

Figure 1. Mastcam-Z Sol 415 (zcam03347) multispectral observation (left eye, 110 mm, natural color) showing head-on the different facies of the thinly-layered unit in the lower delta at Hawksbill Gap location (**A**). (**B**) Decorrelation stretch (DCS) of Mastcam-Z bands RGB: 754 nm, 528 nm, and 442 nm highlight differences in composition along the facies of the lower delta. Magenta/pink/beige colors are associated with ferric iron minerals, while blue/brown/cyan colors are associated with ferrous iron minerals. (**C**) DCS of Mastcam-Z bands RGB: 1022 nm, 910 nm, and 800 nm highlighting differences in composition in infrared bands These spectral differences correspond well with different stratigraphic members in the delta front at Hawksbill Gap, including Devils Tanyard (DT), Hughes River Gap (HRG), Knob Mountain (KM), Boston (BK), Hogwallow Flats (HWF), Lower Rockytop (LRT), and Upper Rockytop (URT).

observed in conglomerate, talus, and some thinly bedded layers along the delta scarp. These spectra are similar to MRO/CRISM spectra of the LCP-bearing Noachian basement exposed in the Jezero crater rim, indicative of transport by fluvial processes [10].

Cape Nukshak Observations: At the base of Cape Nukshak (CN), light-toned thinly-laminated cross-stratified sandstones at "Enchanted Lake" [4,11] are dominated by absorptions at 528 nm and 866 nm consistent with hematite, while some sandstones also show presence of a broad 900 nm absorption consistent with the presence of low-Calcium Pyroxene (LCP). Nearby, dark-toned thinly-laminated siltstones of "Amalik" [4,11] have red and grey banding with hematite absorptions at 528 nm and 866 nm of varying intensities, with reddish bands having stronger ferric absorptions. Further upsection, light-toned recessively weathered siltstones of "Knife Creek" [4,11] have strong 528 nm and 866 nm bands consistent with crystalline hematite. Capping the rim of CN, are dark-toned, coarse-grained layered sandstones of "Alagnak" [4,11], that are characterized by absorptions consistent with the presence olivine and LCP. At "Yori Pass", light-toned siltstones [4] have spectral features consistent with hematite and possible ferric sulfates.

Hawksbill Gap Observations: At the base of Hawksbill Gap (Figs. 1 & 2), finely-layered recessive sandstones of the "Devils Tanyard" (DT) and "Hughes River Gap" (HRG) members [4] also show strong absorptions consistent with hematite, while spectra of some grey coatings suggest the presence of other oxides, such as Mn-oxides [12]. Overlying the DT and HRG members are the dark-toned "Knob Mountain" (KM) and "Boston Knob" (BK) members [4], which include rocks that are dominated by spectral features consistent with olivine and LCP. In the "Hogwallow Flats" (HWF) member, light-toned, finely-layered mudstones [4] show hematite absorptions, while darker platy rocks also exhibit 980-1020 nm downturn indicative of hydrated minerals. Overlying Hogwallow Flats are more resistant layered coarse sandstones to conglomerates of the lower and upper "Rocky Top" (LRT & URT) members [4] with spectral features consistent with the presence of ferric iron, LCP, and hydrated minerals.

Summary: The spectral diversity observed in the sedimentary rocks along the stratigraphy of the delta at the Cape Nukshak and Hogwallow Flats locations preserve a record of variable aqueous conditions, especially variability in redox conditions, during deposition and post-depositional alteration by diagenetic fluids. These observations will help place constraints on an early aqueous environment on Mars that may have been favorable for the preservation of potential biosignatures.

References: [1] Stack et al. (2020), *SSR* 216, 127. [2] Mangold et al. (2021), Science, 374, 711. [3] Farley et al. (2022), Science, 377, 6614. [4] Stack et al., this volume. [5] Williams et al., this volume. [6] Bell *et al. (2020)*, SSR, 217:24. [7] Hayes *et al. (2021)*, SSR, 217:29. [8] Kinch *et al. (2020)*, SSR, 216:141. [9] Rice et al. (2022) JGR, In Press. [10] Horgan et al., this volume. [11] Telbot et al., this volume. [12] Garczynski et al., this volume. [13] Million et al., this volume.

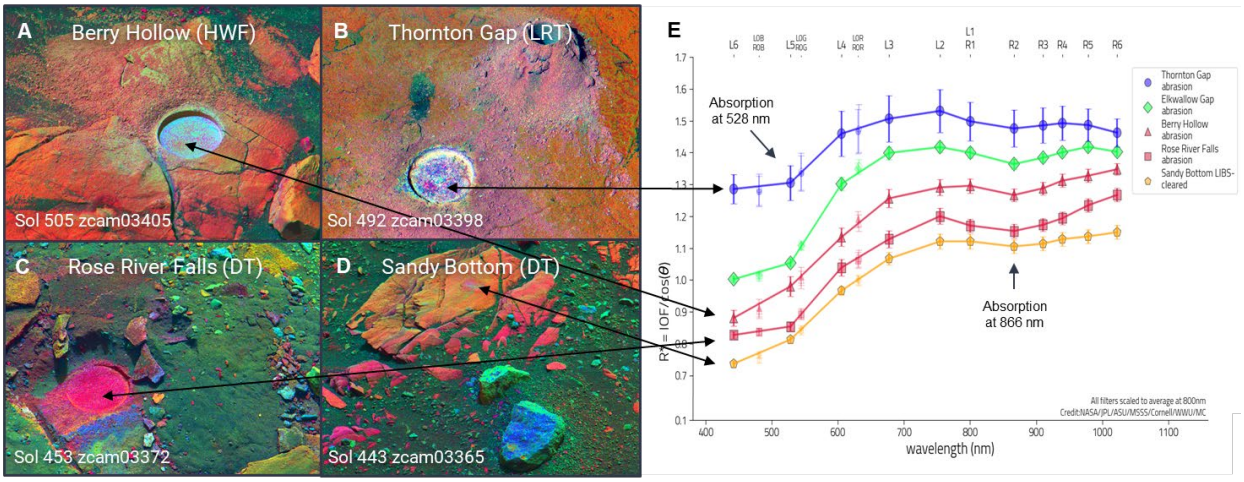

Figure 2. Mastcam-Z Z110 multispectral observations (DCS of RGB: 754 nm, 528 nm, and 442 nm bands) of abrasion patches and dust-cleared surfaces of different facies in the lower delta at Hawksbill Gap, including Devils Tanyard (DT), Hogwallow Flats (HWF), and Lower Rocky top (LRT) members (**A-D**). (**E**) Mastcam-Z VNIR spectra extracted from regions of interest (ROIs) from abrasion patches and dust-cleared surfaces have absorptions due to presence of ferric iron (hematite), but with variable intensity. Graphics generated using [13].