DIVERSE IGNEOUS ROCKS OBSERVED DURING THE MARS2020 CRATER RIM CAMPAIGN IN JEZERO CRATER USING MASTCAM-Z MULTISPECTRAL DATA. E. Ravanis[1], B. Horgan[2], A. Vaughan[3], B. Garczynski[4], J. Johnson[5], A. Klidaras[2], M. Deahn[2], M. Rice[4], C. C. Bedford[2], S. Fagents[1], L. Mayhew[6], C. Quantin-Nataf[7], J. I. Simon[8], J. Bell[9].[1]Uni. of Hawai'i at Mānoa, HI, USA, eravanis@hawaii.edu, [2]Purdue Uni., IN, USA, [3]Apogee Engineering, LLC, AZ, USA, [4]Western Washington Uni., WA, US, [5]Johns Hopkins Uni. Applied Physics Laboratory, MD, USA, [6]Uni. of Colorado Boulder, CO, USA, [7]Uni. of Lyon, France, [8]ARES, NASA Johnson Space Center, TX, USA, [9]Arizona State Uni., AZ, USA.

Introduction: Perseverance began the Crater Rim Campaign (CRC) in August 2024 [1]. The rover has ascended and explored the inner crater rim, and has now driven over to the western side to begin exploration of the *Witch Hazel Hill* area (Fig. 1). Throughout this initial phase of the CRC, Mastcam-Z (MCZ) multispectral data have shown a texturally and spectrally diverse suite of igneous rocks that includes: dark-toned low-calcium-pyroxene (LCP) bearing rocks [2]; light-toned bedrock and float that is red-sloped at MCZ wavelengths, some of which has been shown to correspond to high silica or aluminum [3, 4]; and dark-toned and planar stratified olivine-bearing materials [5, 6]. Here we present an overview of this diversity as seen in MCZ data.

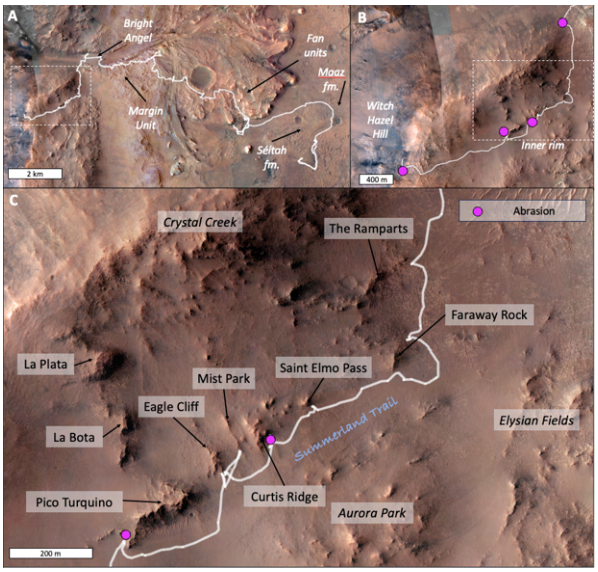

Figure 1: *Context Map. (A) Full mission rover traverse. (B) Crater Rim Campaign traverse up to sol 1363. (C) Inner rim exploration areas. Abrasions indicated by magenta circle.*

Methodology: The Mastcam-Z (MCZ) instrument [4] is a pair of stereoscopic cameras that use Bayer RGB and 14 narrowband filters between 442 nm and 1022 nm to take multispectral images [7]. At MCZ wavelengths, olivine exhibits a peak at the 677 nm band and a strong downturn in the near-infrared (NIR) indicative of the 1 μm ferrous iron band. Ferric coatings, weathered olivine and/or more Fe-carbonate-like spectra display a peak shifted to longer wavelengths, and a less pronounced NIR downturn. LCP-bearing material is distinguished by a broad band centered between 900 and 940 nm, but which can shift to longer wavelengths when mixed with olivine [2]. Decorrelation stretch (DCS) images and band parameter maps are used to assess initial diversity across a scene, and spectra is extracted from regions of interest (ROIs) and compared to laboratory spectra to constrain candidate minerals.

Results—Natural Surface Targets: *In-situ investigations:* During the rover's ascent up the Jezero Crater Rim, *Perseverance* continued to encounter rocks spectrally consistent with olivine/Fe-carbonate, that appear contiguous with the previously explored Margin Unit (Fig. 1A) [8]. Upon exploring a series of ridges and mounds (Fig. 1C), spectra with a strong 939 nm band indicative of LCP-bearing materials were observed in dark-toned rocks at both *Saint Elmo Pass* and *Curtis Ridge*, and in grey-hued, shiny rocks at *Eagle Cliff* [2]. Recessive, lighter-toned material underlying these grey-hued rocks typically exhibited a red-sloped spectral signature. Rocks across the *Eagle Cliff* and *Curtis Ridge* areas generally exhibited a combination of LCP-bearing, red-sloped, and spectrally neutral signature domains within a given rock. This diversity within the rocks themselves may be consistent with crystalline textures and variable degrees of alteration [5, 9, 10]. At the *Pico Turquino* and *Mist Park* ridges, dark-toned and planar-stratified rocks exhibited spectral peaks at 750 nm, and a downturn in the near-infrared followed by a slight upturn past 978 nm (Fig. 2), consistent with a mixture of olivine and small amounts of LCP [2].

Long-distance observations: Observations of outcrops southeast of the rover traverse, such as *Elysian Fields* and *Aurora Park*, suggest a mix of olivine-bearing, LCP-bearing, and spectrally neutral lithologies. The *Crystal Creek* area north of the rover traverse shows apparent discrete packages of material of a red-sloped spectral class as well as LCP-bearing material in succession. The *Saint Elmo Pass* and *Curtis Ridge* crests (observed from ~20 m and ~30 m, respectively), also show material with apparently discrete light and dark-toned clasts that appear spectrally neutral at Mastcam-Z wavelengths, but are consistent with the presence of phyllosilicates in SuperCam VISIR data [5], and which may be impactite [see 6].

Float rocks: Notable float rocks encountered by the rover during the CRC include the 'zebra-striped' *Freya Castle* [11]; oxidized pink rocks at the base of *Curtis Ridge* [2]; and light toned rocks that appear red-sloped (Fe^{2+}-poor) to MCZ, some of which SuperCam data shows to be aluminum-rich [4]; and a cluster in the *Mist Park* area to be silica-rich, including a detection of coarsely crystalline quartz [3] (Figure 2b).

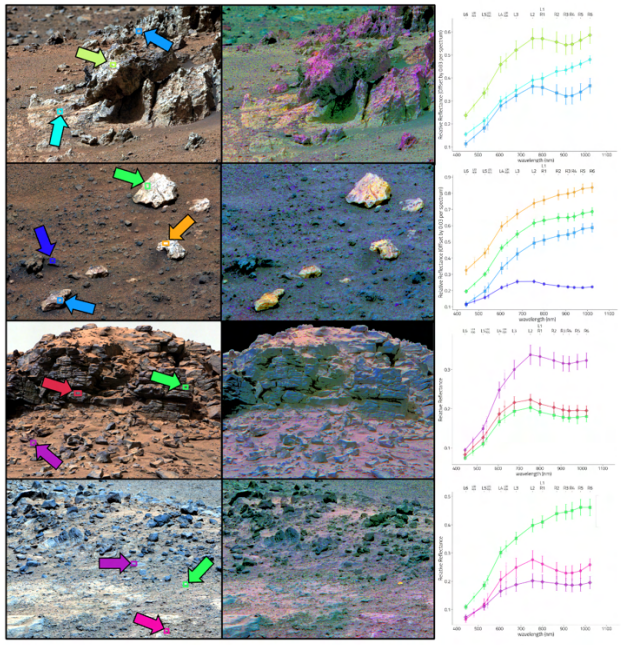

Figure 2: *Example natural surface targets and representative extracted spectra. Left column: enhanced color images. Middle column: near-infrared DCS using R6 (1022 nm), R3 (910 nm), and R1 (800nm) filters, where blue typically corresponds to olivine/Fe-carbonate, magenta/purple to LCP-bearing, and yellow/green to red-sloped or spectrally neutral components respectively. Right column: extracted spectra, with ROIs indicated in enhanced color images. Top to bottom: Mountain_Meadows (sol 1310, sequence ID zcam04014); Muir_Snowfield (sol 1315, zcam04018); Pico_Turquino (sol 1341, zcam04024); Jacksons_Arm (sol 1361, zcam04049). Image credit: NASA/JPL-Caltech/ASU/MSSS.*

Results—Abrasion patches: The *Eremita Mesa* (sol 1258), *Ranger Falls* (sol 1316), *Rio Chiquito* (sol 1335) and *Cat Arm Reservoir* (sol 1361) abrasions have been performed during the CRC (Figure 3). *Eremita Mesa* exhibits spectra consistent with olivine/Fe-carbonate, and is likely part of the Margin Unit. *Ranger Falls* and *Rio Chiquito* abrasion exhibit spectral signatures consistent with both olivine and olivine + LCP mixtures. *Cat Arm Reservoir* in the *Witch Hazel Hill* area is less dominated by olivine, with clear LCP signatures, and may be Noachian basement rock and of interest for sampling [1, 12].

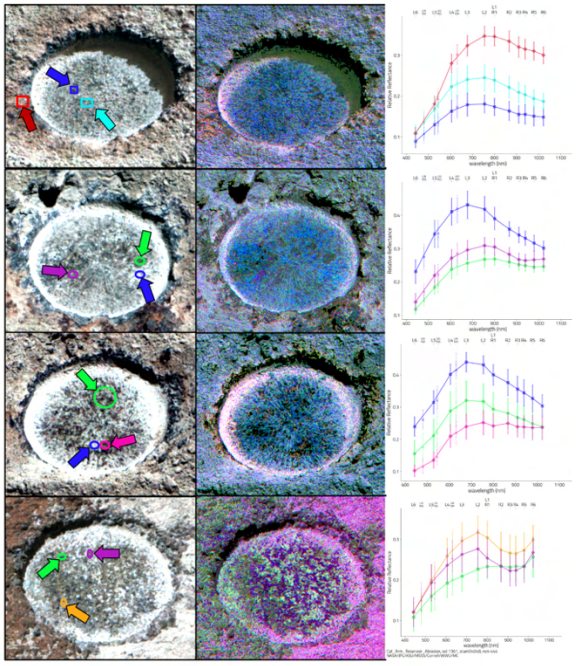

Figure 3: *Abrasion patches (each 5 cm across) from the CRC and representative extracted spectra. Left column: enhanced color images. Middle column: near-infrared DCS using R6 (1022 nm), R3 (910 nm), and R1 (800nm) filters (see Fig. 2 caption). Right column: extracted spectra, with ROIs indicated in enhanced color images. Top to bottom: Eremita_Mesa (sol 1258, sequence ID zcam03971), Ranger_Falls (sol 1316, zcam04019), Rio_Chiquito (sol 1335, zcam04038) and Cat_Arm_Reservoir (sol 1361, zcam04048). Image credit: NASA/JPL-Caltech/ASU/MSSS.*

Summary of spectral diversity: Overall we observe the following main spectral classes both within and between rocks (Figures 2, 3): (1) olivine-bearing, (2) LCP-bearing, (3) red-sloped, (4) spectrally neutral. These spectral signatures are present both within abrasion patches and across different natural surface targets, and this complexity is consistent with a diversity of altered igneous rocks present within the Jezero crater rim. Further in-depth investigation of these varied igneous rocks and comparison to rocks previously explored by *Perseverance*, as well as future Crater Rim Campaign targets, will expand our understanding of ancient terrains on Mars.

References: [1] Mayhew, L. et al. *this meeting*. [2] Vaughan, A. et al. *this meeting*. [3] Beck, P. et al. *this meeting*. [4] Royer, C. et al. *this meeting*. [5] Quantin-Nataf, C. et al. *this meeting.* [6] Horgan, B. et al. *this meeting*. [7] Bell, J. F. et al. (2021) Space Sci. Rev, 217, 1. [8] Ravanis, E. et al. *this meeting.* [9] Bedford, C. C et al. *this meeting*. [10] Udry, A. et al. *this meeting*. [11] Klidaras, A et al. *this meeting*. [12] Herd, C. et al. *this meeting.*