THE COMPOSITION AND THERMOPHYSICAL CHARACTER OF JEZERO CRATER AND ITS SURROUNDING WATERSHED.

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Introduction: Jezero crater, Mars, will be the landing site for NASA's next Mars rover to launch in 2020. Of particular interest for *in situ* exploration are the deltaic deposits associated with two inlet valleys, carbonate-bearing deposits underlying an unaltered mafic capping unit, and a variety of geologic and compositional units representative of the Noachian crust exposed along the western margin of the large Isidis impact basin [1-4]. The diversity of compositional units representing a wide range of geologic processes make this site a compelling location for *in situ* exploration. Here we summarize the visible/near-infrared (VNIR) and thermal infrared (TIR) studies that have been performed on this region of interest, discuss ongoing and future work involving orbital analyses, and highlight the need for spectral validation using the Mars 2020 rover.

Geologic Setting: Jezero is a ~45 km diameter impact crater located along the western margin of the ~1,900 km diameter Isidis basin, one of the youngest impact basins on Mars [5-7], which impacted into the ancient crustal dichotomy boundary. Jezero crater hosts two eroded deltaic deposits along its western and northern interior walls, which were sourced from a watershed of ~30,700 km^2 that extends to the west of the crater towards the Nili Fossae [1]. These deltaic deposits suggest the presence of a paleolake within Jezero during their formation, a hypothesis supported by the presence of an outlet channel, which also helps to estimate water depths [2] (**Fig. 1**). The western deltaic deposit is the better preserved of the two, with intact distributary channels, point bar lateral accretion packages, and foreset and bottomset strata preserved at the distal margin [4,8]. Estimates for the duration of fluvial activity through the Jezero deltas range from 10^0 – 10^7 years [2,4,9,10]. The Jezero watershed encompasses a range of geologic materials emplaced prior to, during, and following the Isidis impact event. These materials represent a diversity of Noachian- and Hesperian-aged materials that originated at a variety of depths within the martian crust [1,11], making this geologic mélange a compelling region for *in situ* exploration.

TIR Spectroscopy (Fig. 2a): TIR emission spectroscopy is sensitive to the vibrational modes of most common rock-forming minerals, including silicates, carbonates, sulfates, and oxides. TIR spectral investigations were the first to identify spectrally diagnostic geologic units in the vicinity of Jezero crater with the identification of widespread enrichments of olivine [12,13]. At the 3x6 km spatial resolution of the Thermal Emission Spectrometer (TES) instrument [14], surfaces in the Jezero watershed and within the crater itself were found to be primarily basaltic in composition with varying amounts of mafic (olivine) and alteration (carbonates, phyllosilicates) phases that do not vary much in abundance by more than ~15% between each unit [15,16]. At the 100 m resolution of the Thermal Emission Imaging System (THEMIS) instrument [17], both carbonate and olivine have been detected at abundances ≥ 20% in this region [16,18], suggesting that greater abundances of both primary and secondary phases can be observed with improved spatial resolution.

Information regarding the thermophysical character of geologic surfaces have also been deduced using TIR data. Thermal inertia, or the resistance of a material to changing temperature, can be assessed through investigation of diurnal temperature variations, with small changes in temperature indicating high thermal inertias and vice versa. Thermal inertias in the vicinity of Jezero crater were found to vary between ~200 and 500 J m^{-2} K^{-1} s$^{-0.5}$, which is consistent with effective particle sizes ranging between 100 μm and > 1 mm [18,19].

VNIR Spectroscopy (Fig. 2b): VNIR reflectance spectroscopy is sensitive to electronic and vibrational absorption features associated with both primary and secondary mineral phases. VNIR spectral data from the Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (OMEGA) [20] and the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [21] were pivotal in characterizing the full range of spectral and, hence, compositional variability in the vicinity of and within Jezero crater [1,3,18,22-26]. The Jezero watershed is cluttered with spectrally diagnostic terrains, ranging from unaltered basalts from the Syrtis Major volcanic province, to fractured bedrock olivine-

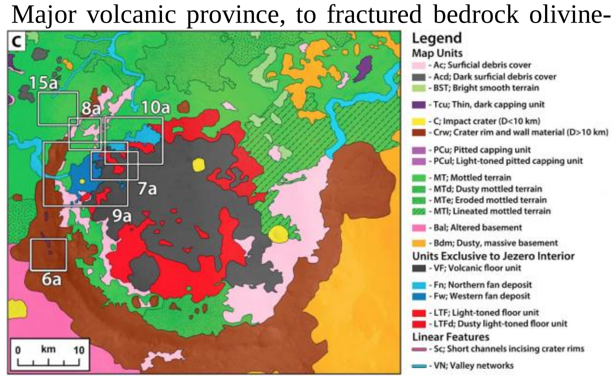

Fig. 1. A geomorphic and spectrally validated map of Jezero crater (modified from [1], Fig. 4c). Interior labels refer to figures in [1].

and carbonate-bearing plains, to heavily eroded Fe/Mg-smectite-bearing basement terrains.

Jezero crater itself exhibits spectral signatures that encompass the full range of those identified within its watershed [1]. The lowermost unit within the crater is the olivine- and carbonate-bearing light-toned floor unit, which is overlain by an unaltered mafic floor unit. The western Jezero delta shows evidence for both smectites and carbonates, and the inner margins of the crater also exhibit evidence for carbonates. These marginal carbonates are hypothesized to be genetically related to the carbonate-bearing mottled terrain in the surrounding watershed, which would shed light on the formation and emplacement processes of these units.

Ongoing & Future Work: Improved spectral analysis methods are ongoing to identify minor spectral phases and to further constrain mineral abundances throughout the region. For example, Hapke modeling, Discrete Ordinate Radiative Transfer (DISORT) modeling, and factor analysis and target transformation (FATT) techniques [27] are all being implemented to test the mode of formation of the carbonate-bearing lithologies in and around Jezero crater, as determining the co-occurrences and abundances of minor phases is essential towards understanding modes of formation.

Furthermore, the Mastcam-Z [28] and SuperCam [29] instruments onboard the Mars 2020 rover will provide critical VNIR spectral information to validate orbital data and improve unmixing models by identifying and characterizing spectral endmembers. The Mars 2020 rover provides us with a unique opportunity to validate past, current, and future remote sensing datasets through contemporaneous and synergistic surface characterization, well-planned spectral observations, and the selection of appropriate samples for caching and eventual return to Earth.

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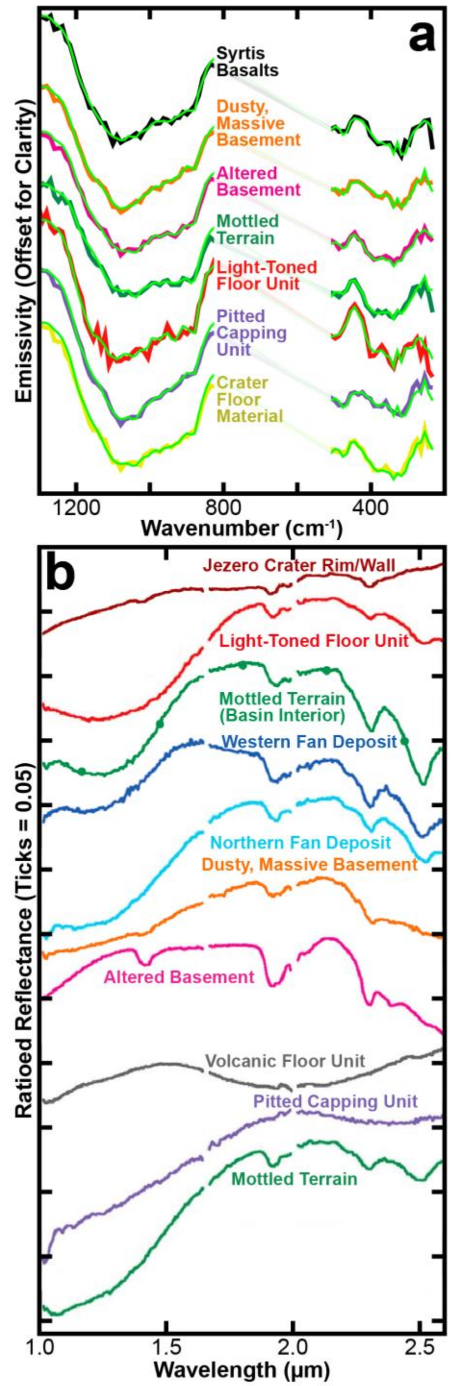

Fig. 2. Representative TIR (a) [17] and VNIR (b) [1] spectra from Jezero crater and watershed. TIR modeled results are also shown as thin green lines.