JEZERO CRATER RIM FROM ORBIT: MAPPING DIVERSE TARGETS FOR THE MARS 2020 ROVER.

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Introduction: The Mars2020 rover is approaching the rim of Jezero crater, to collect samples for potential future return to Earth by Mars Sample Return (MSR) [1]. Jezero is a mid- to late-Noachian-aged crater superimposed on an inner ring of Isidis, one of the largest known impact basins on Mars [2]. The early geologic history of Mars may be recorded in the rim of Jezero, as it may have excavated deep crustal materials and the ancient stratigraphy of Isidis impact ejecta, providing a window into the history of the crust [3]. Impact megabreccia in the crater rim may be exhumed pre-Noachian crust, which would likely be the oldest materials investigated on Mars [4]. Additionally, the rim may preserve evidence of ancient hydrothermal environments [5], as well as recent regional capping units key for understanding NE Syrtis volcanism [6].

This study provides an update on the now complete 1:2500 scale photogeologic map of the ~14.5 x 3.5 km area around the Jezero crater rim [7], building on regional mapping of the area [2,5,8]. The goal of this research is to identify geologic diversity and key scientific targets in the rim through geologic mapping.

Mapping Effort: Mapping was primarily conducted using a High-Resolution Imaging Experiment (HiRISE) basemap, clipped to the Jezero crater region at ~25 cm/pixel resolution [9]. We also referenced the Mars 2020 Digital Terrain Relative (DTM) Navigation HiRISE Mosaic at ~1 m/pixel resolution [10]. These datasets were used to discern surficial and morphologic units along the crater rim using the CAMP (Campaign Analysis Mapping and Planning) tool [11], and later reconciled in ArcGIS Pro.

A subset of the Mars 2020 Science Team collaborated to produce the photogeologic map [5]. The map was divided into 36 quadrants and assigned a mapping lead. Contacts were drawn between clear unit boundaries - defining units based on morphology, texture, relative brightness, and topography. Mapping specialists reconciled the contacts between quadrants, and a scientific reconciliation ensured continuity in naming and interpretation across quadrants. The full map was converted to a local 3D Scene in ArcGIS Pro referencing the DTM to draw surface profiles. Topography was measured across five areas within the map scene. Unit boundaries were measured along profile lines in ArcGIS Pro, and then plotted using the corresponding unit colors to draw surface profiles in MATLAB. These profiles reveal the relationship between the units and the elevations at which they are preserved and exposed.

The Geology of the Rim: The photogeologic map of the Jezero crater rim reveals 18 geologic units: 6 surficial and 12 bedrock units. Surficial units typically

Unit name	Description	Occurrence
Crater rim knobby	intermediate-toned, smooth mantle with irregularly scattered knobs	high standing topography; expansive across central map area
Crater rim rubbly	intermediate to dark-toned, blocky irregular outcrop that disaggregates into meter-scale boulders	high standing topography, above *knobby* units; expansive across central map area
Light-toned fractured	light-toned, disaggregated materials with meter-to-decameter-sized polygonal dark filled fractures	occurs in heavily eroded, variably sized, continuous and discontinuous patches along the margins of the crater rim
Light-toned banded	light-toned, disaggregated material with alternating bright and dark-toned lineaments, often curvilinear and dissected by faults	occurs in continuous patches along the western slopes of the high-standing topography along the crater rim
Light-toned ridged	light-toned furrowed rises with ridge- parallel lineations	found around the margins of the crater rim
Margin knobby	intermediate-toned, smooth mantle with irregularly scattered knobs	high to moderate topography; expansive across eastern map area
Margin rubbly	intermediate to dark-toned, blocky irregular outcrop that disaggregates into meter-scale boulders	high to moderate topography, above *knobby* units; expansive across eastern map area
Mottled	irregular and patchy light and dark-toned fractured materials expressed as coherent blocks meter- to decameters in scale	found in scattered patches along the margins of the rim
Rough banded	rough, variably toned, disaggregated material; contains meter-scale layering/lineations and light-toned fractured materials	occur in mesa like formations in the low topography regions between the rises; underlies the *rough cratered* unit
Rough cratered	rough, variably toned, crater-retaining, disaggregated material; with dark infill	occur in mesa like formations in the low topography regions between the rises; overlies the *rough banded* unit
Rough fractured	disaggregated bedrock with meter to decameter polygonal fractures, high-standing ridges, and a rubbly surface texture	found along the western edge of the crater rim transitioning into Nili Planum region
Streaked	intermediate to dark-toned; appears to be dust covered bedrock; subtle lineations in these textures occur perpendicular to slope	occurs along the western slopes of high standing topography

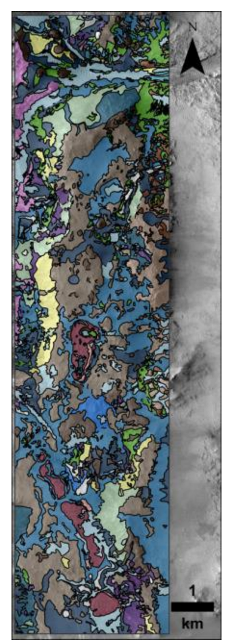

Table 1: *Crater rim map bedrock units with full map shown at right.*

conceal underlying bedrock in topographic lows. Bedrock units (Table 1) suggest diverse impact, volcanic, and sedimentary lithologies are present in the crater rim.

Uplifted basement materials. Jezero crater rim may contain evidence of ancient crustal rocks [12]. Crustal basement in the region is described as smooth relative to younger volcanic units, and as heavily eroded, with knobs, mounds, and ridges [12]. The expansive nature of the *knobby* and *rubbly* units along the center of the rim suggests they may be exposures of uplifted ancient crustal materials. The *crater rim knobby* unit is exposed at higher elevations, and predominantly infilled at lower elevations with surficial units or draped by possible volcanic materials (Fig. 1A). The *light-toned banded unit*, which is typically found in association with the *knobby* units on the west-facing slopes may also be uplifted layered Noachian basement materials (Fig. 2).

Regional volcanism. The NE Syrtis region is draped by a series of proposed Noachian volcanic deposits, including the olivine-rich and mafic capping units [12]. The regional olivine-rich unit is typically characterized as being light-toned, with polygonal fracturing and some exposures showing horizontal layering [13,14]. It drapes the basement materials and underlies a crater-retaining dark mafic capping unit [13]. Both are commonly found in topographic lows, and often occur together at mesas [12]. On the crater rim, several units may be equivalents of these regional units, including the *rough fractured*, *rough banded*, and *light-toned fractured* units, based on their fractured surface expressions (Fig. 1B) and presence in topographic lows overlying the knobby and rubbly units (Fig. 2). The *rough cratered* unit exhibits similar morphologies to the mafic capping unit and overlies the *rough banded* unit in a series of mesas. Additionally, the *light-toned ridged* unit may either be an additional mesa of the olivine-rich unit or a fracture network with a magmatic origin (Fig. 1C).

Hydrothermal systems. Crater rims have the potential to host impact-induced hydrothermal systems [15]. Fracture networks can serve as pathways for fluids [15], so an alternative hypothesis for the origin of the *light-toned ridged* unit (Fig. 1C) could be a resistant filled fracture network that is hydrothermal in origin. The *light-toned banded* unit may also be a candidate for hosting evidence of hydrothermal alteration, as compositional datasets along the rim show possible smectite signatures associated with this unit. Additionally, the *light-toned fractured* materials may have formed as hydrothermally altered rim materials during the Jezero impact rather than regional volcanism.

Impactites. Some rim materials may represent either Jezero or pre-Jezero impactites. One such material could be megabreccia (the *mottled* unit), or blocks of rocks that form during the initial impact and subsequent collapse of the crater during formation [4]. The *mottled* unit is characterized as containing irregular and patchy light and dark-toned fractured materials expressed as coherent blocks m- to dm in scale (Fig. 1D). They are likely to be either blocks of ancient crust uplifted and exposed during the Jezero impact, or blocks formed during the Jezero impact itself. Relationships between the megabreccia unit and surrounding impactite and uplifted units will be critical for reconstructing the impact history of Jezero and the source of the blocks.

References: [1] Farley et al. (2020) *Space Sci. Rev., 216,* 142. [2] Goudge et al. (2015) *JGRP, 120,* 775–808. [3] Sacks L. E. et al. (2022) *Icar, 375*, 114854. [4] Scheller & Ehlmann (2020) *JGRP, 125,* e2019JE006190. [5] Stack et al. (2020) *Space Sci. Rev. 216,* 127. [6] Hundal et al (2022) *Geophys. Res. Lett., 49,* e2021GL096920. [7] Deahn et al. (2024) *55th LPSC*, abs. #2302 [8] Sun & Stack (2020) *Sci. Inv. Map*. 3464. [9] McEwen et al. (2007) *JGRP, 112*, E05S02. [10] Fergeson R. L. et al. (2020) *51st LPSC*, abs. #2020. [11] Calef et al. (2023) *54th LPSC,* abs. #2914 [12] Bramble et al. (2017) *Icar, 293,* 66-93. [13] Mandon et al. (2020) *Icar, 336,* 113436. [14] Kremer et al. (2019) *Geology, 47,* 7. [15] Osinski et al. (2013) *Icar, 224,* 347-363.

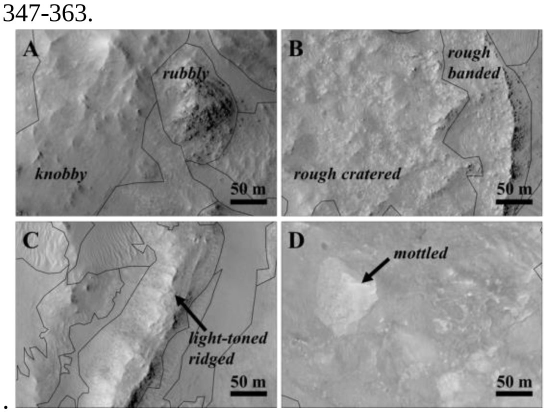

Figure 1: *Unit contacts on the crater rim, representing possible (A) uplifted basement, (B) regional volcanism, (C) hydrothermal remnants, and (D) impactites.*

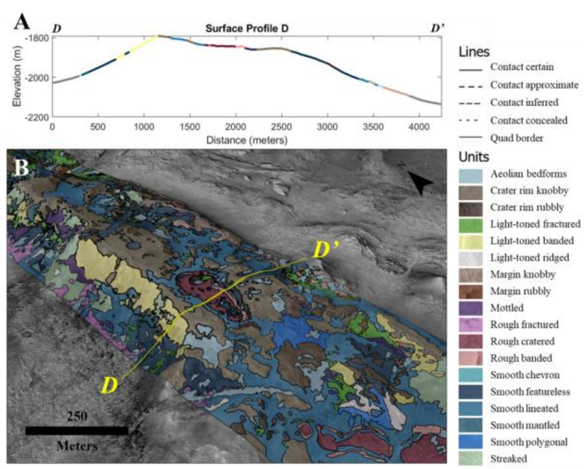

Figure 2: *(A) Surface profile of the central map region. (B) Corresponding 3D orbital image of the map with 2x vertical exaggeration and profile line.*