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► **To cite this version:**

Alex J. Jones, Sanjeev Gupta, Robert Barnes, Briony H. N. Horgan, Gerhard Paar, et al.. Reconstructing the Sedimentology and Depositional Setting of the Margin Unit, Jezero Crater. 55th Lunar and Planetary Science Conference, Lunar and Planetary Institute, Mar 2024, The Woodlands (Texas), United States. pp.1994. hal-04442900

HAL Id: hal-04442900

<https://hal.science/hal-04442900>

Submitted on 6 Feb 2024

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RECONSTRUCTING THE SEDIMENTOLOGY AND DEPOSITIONAL SETTING OF THE MARGIN UNIT, JEZERO CRATER. A. J. Jones¹, S. Gupta¹, R. Barnes¹, B. Horgan², G. Paar³, K. Stack⁴, B. Garczynski², R. Williams⁵, J. Bell⁶, J. Maki⁴, S. Alwmark⁷, E. Ravanis⁸, F. Calef⁴, L. Crumpler⁹, K. Williford¹⁰, A. Vaughan¹¹, J. Simon¹², S. Gwizd⁴, C. Tate¹³, A. Annex¹⁴, A. Klidas², K. Farley¹⁴, N. Randazzo¹⁵, N. Schmitz¹⁶, L. Kah¹⁷, A. Brown¹⁸, G. Caravaca¹⁹, N. R. Williams⁴, ¹Imperial College London, UK, (alexander.jones19@imperial.ac.uk) ²Purdue University, IN, USA, ³Joanneum Research, Austria, ⁴JPL, Pasadena, USA, ⁵Planetary Science Institute, AZ, USA ⁶ASU, Tempe, USA, ⁷University of Copenhagen, Denmark, ⁸Hawai'i Institute of Geophysics and Planetology, HI, USA, ⁹New Mexico Museum of Natural History and Science, NM, USA, ¹⁰Blue Marble Space Institute of Science, WA, USA ¹¹Apogee Engineering, AZ, USA, ¹²NASA Johnson Space Centre, Houston, USA, ¹³Cornell University, NY, USA, ¹⁴Caltech, Pasadena, USA, ¹⁵University of Alberta, Canada, ¹⁶German Aerospace Center (DLR), Germany, ¹⁷University of Tennessee, TN, USA, ¹⁸Plancius Research, MD, USA, ¹⁹IRAP, CNRS, CNES, Univ. Toulouse, France.

Introduction: The Margin Unit of Jezero crater is an olivine- and carbonate-rich geologic unit stratigraphically underlying the Jezero Western fan, tracing the inner margin of the western crater rim, and is of significant astrobiological interest [1]. However, the origin of the Margin Unit is uncertain. The distribution of the unit around the inner margin of the crater rim and its strong orbital carbonate signature led to one interpretation of the Margin Unit as a lake shore precipitate [1] either coeval with, or predating, the Western fan [2]. Alternate hypotheses include fluviolacustrine or aeolian [3], or part of a regional carbonatized lava flow or pyroclastic deposit [4-6]. Here, we report on *Perseverance* rover observations of the sedimentology and 3D architecture of the Margin Unit explored between sols 910 – 1028, with the objective of characterizing the unit and understanding its emplacement/depositional processes.

Methods: Images taken by the Mastcam-Z cameras, supplemented with Remote-Micro-Imager (RMI) images from the SuperCam instrument and Return To Earth (RTE) images taken by the Mars Helicopter Ingenuity were analysed to characterize the sedimentary textures and structures within the Margin Unit. 3D data generated by the Planetary Robotics processing and viewing tools PRoViP and PRo3D were then also used to map the 3D architecture of the unit [7].

Observations: The Margin Unit largely comprises sub-horizontal to low-angle inclined beds <70 cm thick, with many showing internal sub-cm scale plane parallel lamination. PIXL analyses and SHERLOC WATSON and ACI images indicate that it comprises moderately- to well-sorted, medium to coarse sandstones, rich in olivine and secondary phyllosilicates and carbonates [8, 9]. Mastcam-Z landscape images show that the unit largely consists of fractured, discontinuous outcrops, making stratigraphic correlation challenging. However, three main architectural elements can be distinguished:

Basinwards-dipping strata: This element is characterized by strata dipping broadly eastwards towards the center of the crater, and is observed from the Hans Amundsen Memorial Workspace (sol 910) to

Gnaraloo Bay (sol 998). Dip measurements range from 5 – 20°, with azimuths between 027°- 137°, (mean 12/088). Beds appear to gently flatten out down-dip, occasionally becoming lenticular and convolute.

Rimwards-dipping strata: This element is observed in the area around Turquoise Bay (sols 929 – 952), and comprises beds with dips ranging from 5 - 25° and dip azimuths trending broadly west towards the crater rim, ranging between 216° - 325° (mean 12/273). Mastcam-Z and SuperCam RMI images reveal candidate cross bedding inclined northwest, with sub-horizontal bounding surfaces separating sets 3 – 10 cm thick (Fig 1a). Sparse, thinner-bedded, finer-grained horizons are also present forming possible trough cross bedding (Fig 1b). Locally, erosion surfaces show truncation of underlying strata (Fig 1c). Ingenuity RTE imagery reveals gently arcuate bedding traces in planform (Fig 1d), possibly indicating a fan-like bedding geometry.

Sub-horizontal strata: This element is observed throughout the Margin Unit and comprises low-angle beds sometimes associated with concentric, elliptical structures typically 1 – 3 m across, which may be considered inherent to the strata (i.e. hummock-like beds) or a product of spheroidal weathering (Fig 1e). Due to the inconsistent outcrop and the dip variation of the basinwards and rimwards inclined architectures, it is possible this is a shallow dipping subset of one or both the architectural elements described above.

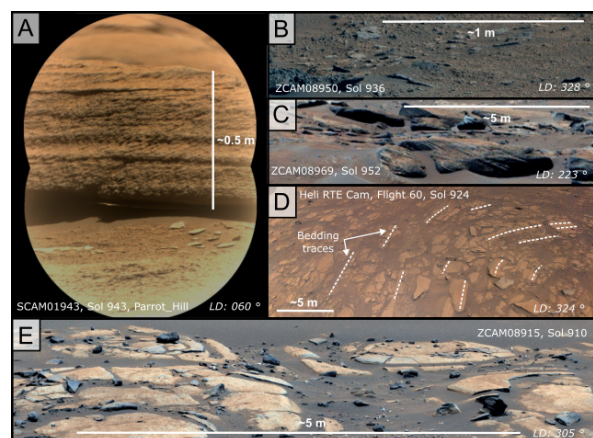


Fig 1: Sedimentary features observed in the Margin Unit.

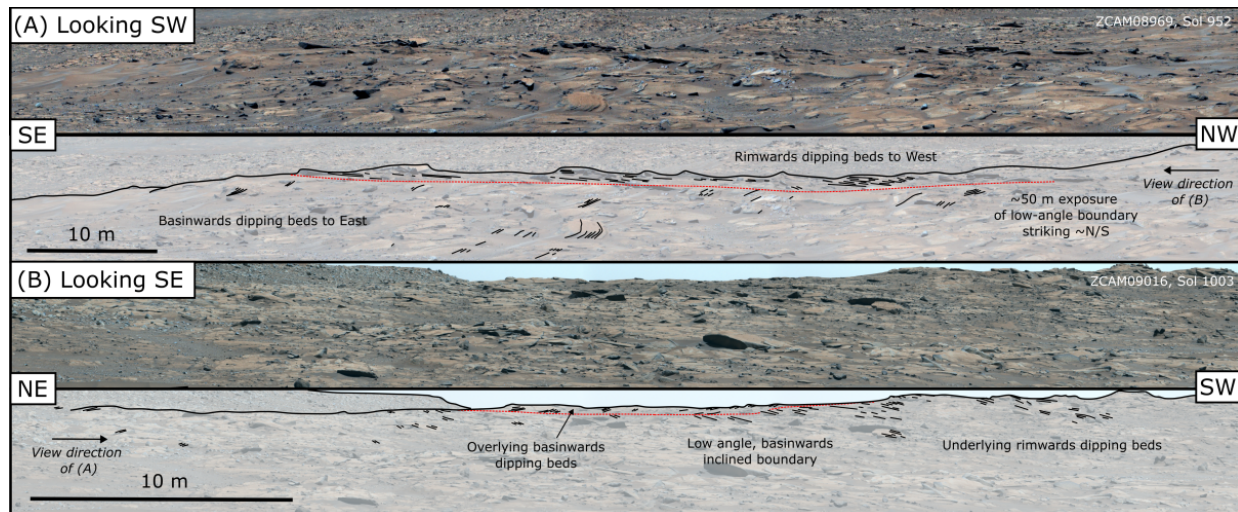


Fig 2: Orthogonal Mastcam-Z mosaics of Turquoise Bay, showing the juxtaposition of basinwards dipping strata atop rimwards dipping strata.

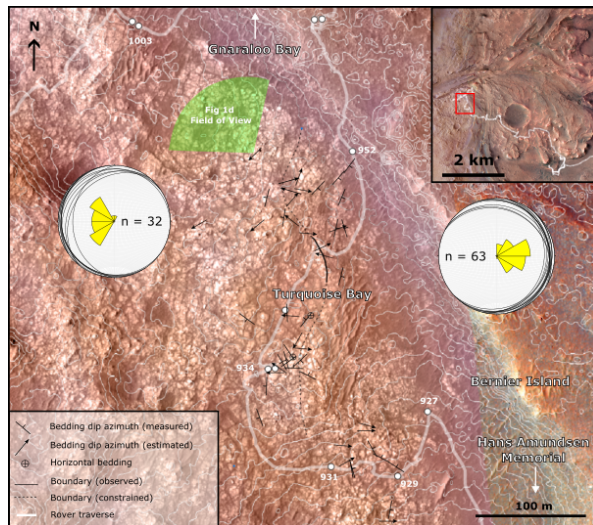


Fig 3: Structural map of the area around Turquoise Bay, with 1m contours and regional context map shown. Stereonets show the bimodal orientations of strata either side of the juxtaposition surface. Green arc shows Ingenuity view for Fig 1d.

Large-scale architecture: Basinwards-inclined strata are truncated by overlying rimwards-inclined strata along a broadly north-south striking, east dipping surface which outcrops at the surface for ~50 m (Fig 2). Mapping of stratal dip azimuths around Turquoise Bay reveals this juxtaposition surface may extend much further, for at least 300 m in length (Fig. 3).

Interpretation: Our documentation of the first order sedimentology of the Margin Unit enables us to explore one possible interpretation of the depositional setting of this unit. We posit that the Margin Unit around Turquoise Bay preserves a lacustrine shorezone beach bar-type deposit. Alternating sets of lakeward and shorewards dipping beds are characteristic of lake beach bar deposits on Earth, where bars are constructed parallel to the coast (in this case parallel to the inner

margin of the crater rim) by shorezone processes such as wave action [10]. During fairweather conditions, swash causes deposition of low-angle, sigmoidal beds along the lakewards-dipping side of the bar, such as those seen in the east of the study area. During conditions of increased lake level or wave height, washover sheets and fans are formed on the inshore-facing side of the bar, as clastic sediment is transported over the top of the ridge crest, truncating underlying material [11]. This may be consistent with the rimwards dipping and potentially fan-shaped strata seen in the west of the study area. The sedimentary structures observed including low-angle hummock-form beds and cross stratification are also shared with terrestrial beach bar deposits [12]. This interpretation follows previous orbital work which shows that the Margin Unit's distribution follows topography, around the base of the inner flank of the crater rim, consistent with emplacement at the shoreline of a shallow lake within the crater [1]. This is also in agreement with inferences of aqueous emplacement from abrasion patch and core sample textural analyses [8]. We note that our interpretation is preliminary and additional formation hypotheses (for example those discussed in [3, 13]) require consideration and testing during continued exploration of the unit.

Acknowledgments: The authors would like to thank the Mars2020 operations teams for their work acquiring the data used in this study, as well as project management for effective running of the mission.

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