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## EVIDENCE OF STRANGLINES FROM A LATE LACUSTRINE EVENT WITHIN GALE CRATER.

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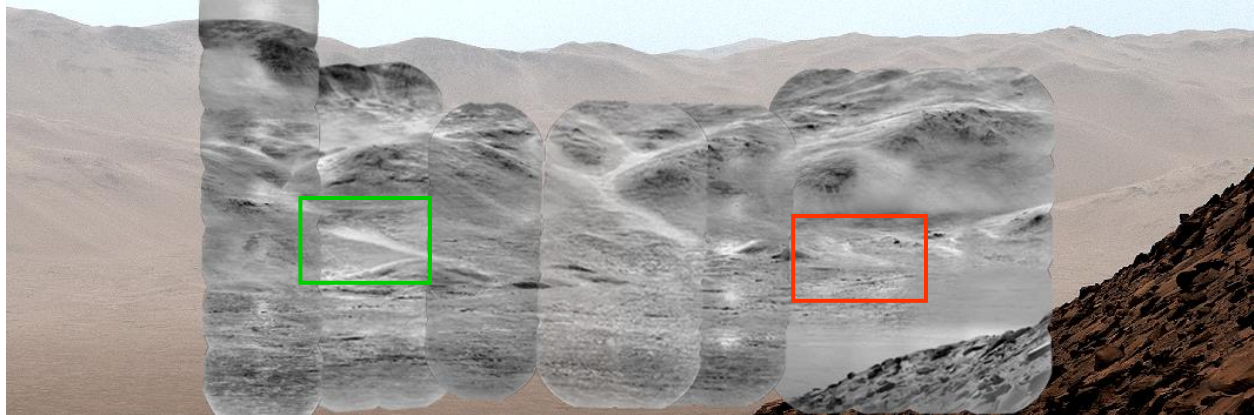


Figure 1. A view of the Gale crater rim and associated alluvial bajada. The black and white imagery represents high-resolution ChemCam RMI mosaics on Mastcam color imagery. The red and green boxes are shown in Figure 3 top and bottom respectively.

**Introduction:** Gale crater hosted several lacustrine events based on mineralogic and sedimentary observations from the Mars Science Laboratory (MSL) rover. We now report observations of strandlines recording the paleo-shorelines of a lacustrine event detected along the NE crater rim alluvial bajada (Fig. 1) and the NW crater rim alluvial bajada (not shown).

*Paleo-lake strandline deposits on Earth.* Paleolakes on Earth provide an analog for understanding the morphology of potential strandlines on Mars. Such deposits (Fig 2) are depositional and/or erosional (wave cut) features that usually record the most recent regression of a water body at the recorded level.



Figure 2. A ~170 m vertical package of Pleistocene paleolake strandlines on Shoreline Butte, Death Valley, CA.

**Rover Observations:** The Peace Vallis Campaign of the MSL rover is a multi-season effort to document the Peace Vallis fan, crater floor, crater rim, and alluvial bajada within Gale crater. These features are ~10-40 km distant from the rover traverse, so imaging is only possible during low atmospheric opacity. During the latest campaign, imaging of the NE crater rim bajada produced a series of adjoining ChemCam Remote Micro-Imager (RMI) mosaics showing a sequence of laterally continuous, horizontal benches.

**Results:** The horizontal benches span the entire length of the RMI mega-mosaics (Fig. 1) between -3900 and -3500 m. Figure 3 displays sections of these

benches extending for over 4 km horizontally along the alluvial bajada illustrated by the yellow lines. Some of the strandline features are observed to curve with local topography from the rover perspective (Fig. 3).

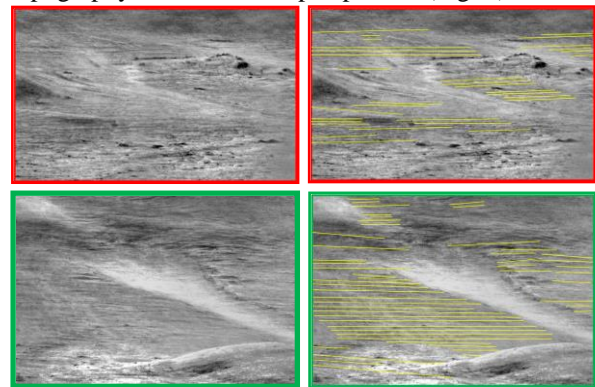


Figure 3. Left: Zoom-in views of ChemCam RMI mosaics LD\_Peace\_Vallis\_3834 (top) and LD\_PV\_3859 (bottom). Right: line-annotated images showing continuous, horizontal strandline benches for images on the left.

*Strandline Profiles.* Spectral analysis of brightness variations along a transect on the NW crater rim bajada (A-A' HiRISE ESP\_022467\_1760) perpendicular to the strandlines at Figure 3 (bottom), allowed estimation of the perpendicular distance and elevation between the benches (Fig. 4). A highly significant peak in power at a frequency of ~0.032 substantially above background noise suggests a regular distance/elevation trend. Maximum spectral power corresponds to a horizontal spacing along the profile of ~50 m with an average vertical change of ~6.25 m between strandline features. This regularity is expected for shorelines on a shallow slope where local topography plays a minimal role, such as the alluvial bajada of a crater rim.

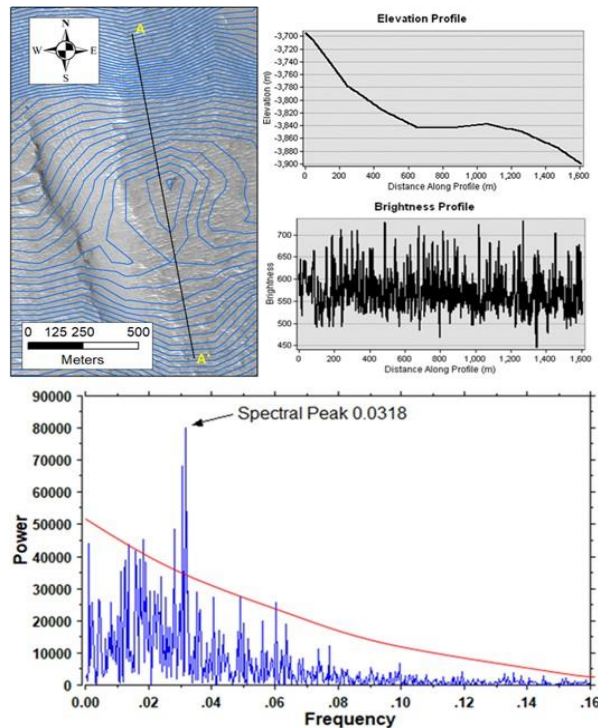


Figure 4. Left: transect perpendicular to strandlines (A-A'). Top right: elevation profile of transect (~4x vertical exag.). Mid-right: brightness profile. Bottom: spectral analysis (red line= 95% red-noise confidence interval).

**Discussion:** The current atmospheric pressure on Mars could generate waves on the surface of a Gale sized lake based on previous modeling [1]. However, during past high obliquity events, the atmosphere thickens with the introduction of more CO<sub>2</sub> from the polar caps. During this time, melting of midlatitude glaciers and subsurface ice contribute to more water vapor, leading to increased precipitation. This all correlates to a higher probability of lake filling and wave generation.

Other models show that despite lower gravity, lacustrine waves on Mars are capable of transporting sediment to produce shorelines [2]. The benches observed in this study are prominent, sedimentary deposits and/or wave-cut features that have been subject to minimal erosional degradation since emplacement. We interpret them to be the result of a relatively recent lacustrine event due to their current preservation state i.e. lack significant erosion. A young age, post deposition of Mt. Sharp sediments, is supported by studies finding recent alluvial deposition [3] and groundwater sapping structures [4] on the Peace Vallis fan based on crater counts. While previous studies show a fetch length of >20 km can produce waves on Mars [1], the absence of strandline features on other segments of the crater rim are likely due to short fetch lengths for NW-SE wind directions

on a Gale lake (Fig. 5). This notion, along with the shoreline geometry differences of crater rim bajada and Mt. Sharp and potential lake depths, could explain why significant strandlines are not seen along the rover traverse. Furthermore, the stratigraphic position of other alluvial/deltaic deposits within Gale lends support to shorelines existing at these elevations.

The presence of shorelines in a late Gale lake indicates the surface was liquid water and not perennially covered with ice. This idea is supported by the lack of dropstones and ice-melt dust piles observed in the sediments along the rover traverse.

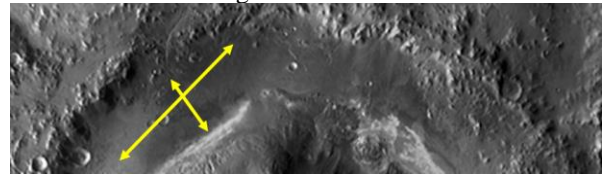


Figure 5. Orbital view of Gale crater showing potential fetch lengths, assuming Mt. Sharp was present.

**Alternate Hypotheses:** Other explanations for these benches do not support the unique morphology or horizontal continuity observed in this study. Lacustrine outcrops imaged along the rover traverse likely extended across the crater before the current crater exhumation state. However, such sediments would be apparent along other segments of the crater rim bajada and not just in the NE and NW sections. The periodicity of the deposits is also too regular to be similar to observed Gale lacustrine sediments. These deposits also do not appear to resemble bedrock observed higher on the rim, which is massive igneous material. Another explanation could be eroded alluvial sediments, but this would require extremely regular, extensive sheetfloods revealed by aeolian erosion. This is not analogous to the structure of alluvial bajada sedimentation/erosion on Earth as the benches are too laterally continuous and vertically consistent.

**Conclusions:** Based on visual observations and analytical techniques, we find the horizontally continuous, linear benches on the northeast and northwest Gale crater rim bajada to be paleolake strandline deposits from a recent (<2 Ga) lacustrine event. This parallels evidence of other late alluvial and fluvial events observed within the crater as well as other potential strandlines proposed at this meeting [5].

**Acknowledgments:** The ChemCam and Mars Science Laboratory rover science teams and engineering teams.

**References:** [1] Rubin et al. (2022) JGR: Planets 127(4) e2021JE007162. [2] Adams (2023) Icarus 405, 115695. [3] Grant and Wilson (2019), GRL 46(13), 7278-7294. [4] Scuderi et al. (2018) LPSC L #2714. [5] T. J. Parker et al. (2024) LPSC LV #2483.