IN CURIOSITY'S PATH: THE GEOMORPHOLOGY AND STRATIGRAPHY OF THE GREENHEUGH PEDIMENT AND GEDIZ VALLIS RIDGE IN GALE CRATER. A. B. Bryk[1], W. E. Dietrich[1], M. P. Lamb[2], J. P. Grotzinger [2], A. R. Vasavada[3], K. M. Stack,[3] R. Arvidson[4], C. Fedo[5], K. Bennett[6], V. K. Fox[2], S. Gupta[7], R. C. Wiens[8], R. M. E. Williams[9]. [1]University of California, Berkeley, CA (bryk@berkeley.edu). [2]Division of Geological & Planetary Sciences, California Institute of Technology, Pasadena, CA. [3]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA [4]Washington University in St. Louis, St. Louis, MO. [5]University of Tennessee, Knoxville, TN. [6]USGS Astrogeology Science Center, Flagstaff, AZ. [7]Imperial College, London, UK. [8]Los Alamos National Laboratory (LANL), Los Alamos, NM. [9]Planetary Science Institute, Tucson, AZ.

Introduction: Curiosity's continued ascent of Aeolis Mons (Mt. Sharp) will provide access to landforms and deposits that likely record major environmental changes in Gale crater's geologic and climatic history (Fig. 1). We first describe the landforms, then review hypotheses regarding origins, and present new stratigraphic observations.

The lower ~2.5 km of Gediz Vallis (GV) is an ~800 m wide roughly 75 m deep U-shaped valley (A). A 15 m high, 100 m long boulder-rich ridge appears to be a deposit that extends partially across the valley floor (Fig. 1b at A) and abuts a channel that begins ~200 m upslope. The ridge deposit may record late stage landslides or, perhaps glacial activity. The ~100 m wide channel is sharply cut into the valley floor, chocked with boulders, and progressively fills with debris downslope, becoming inverted (B, C) as it crosses to GV ridge (D). The ridge extends downslope nearly 2 km (D) and stands 70 m above the adjacent plain at its highest elevation. The surrounding plains, named the Greenheugh pediment, covers nearly 3 km^2 and progressively declines in gradient downslope from 25% to 12% over ~1400 m distance. Although approximately fan-shaped, the surface lacks the planform convexity characteristic of terrestrial alluvial fans (Fig. 1a). Instead, this relatively gently inclined surface has a nearly planar slope, which truncates underlying strata, hence earning the label "pediment". The pediment surface is rough, preserving small impact craters and exhibits well-organized relatively evenly-spaced (~10 m) ridges.

Previous studies using orbital data have interpreted the GV ridge as a fan deposit, but differ as to whether the pediment preceded or post-dated the GV ridge, and whether these features formed during construction of Aeolis Mons, or during a final erosional phase [1,2,3, 4]. [2] proposed that the pediment surface might have been covered with dunes and is part of an extensive "mound skirting unit" that they mapped in the northern part of Gale crater. Based on stratigraphic mapping by the Curiosity team, and observations of the pediment surface, [5] proposed that the surface deposit is the upslope equivalent of the Stimson formation, a unit that is interpreted to record a shift to a period of aeolian dune transport and deposition after an earlier episode of exposure and erosion of Murray formation lacustrine deposits. All previous interpretations point to a major shift in geomorphic, sediment transport, and thus climatic conditions responsible for these features, but the proposed processes and timing differ. Here we offer new observations made possible by Curiosity Mastcam and Chemcam LD RMI images and high resolution 3-D images from HIRISE data of these features.

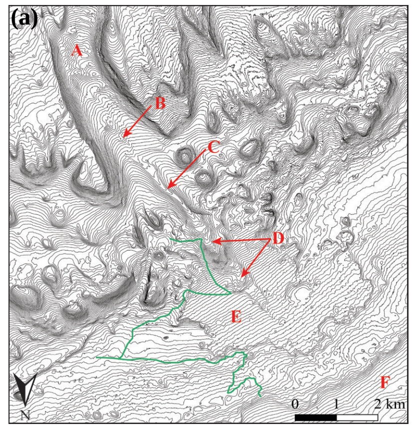
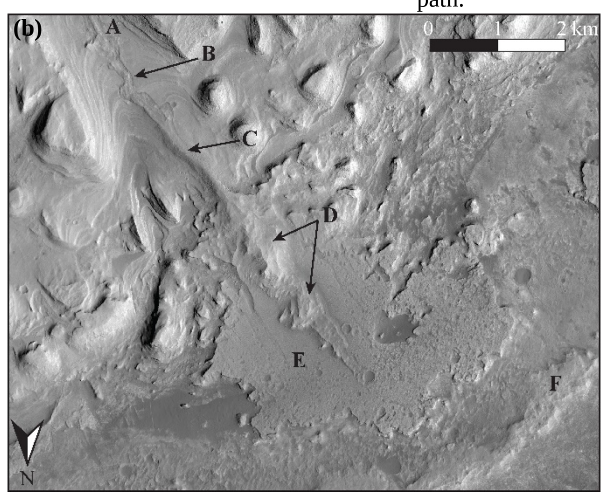


Fig. 1a and b. (5m cont. int.) and shaded relief map merged with HiRISE for the GV area. (A) Gediz Vallis (B) Channel, (C) Inverted channel, (D) Gediz Vallis ridge, (E) Greenheugh pediment, and (F) Vera Rubin Ridge. The green line indicates the proposed rover path.



Observations: Fig. 2 shows an example of the Mastcam and Chemcam images of the downslope eroded exposure of the pediment cap opposite the Vera Rubin Ridge. Mastcam images of >1km of the exposed edge reveal that the pediment is capped by about 1 m of dark gray rock, most likely sandstone that displays multiple cross-bed orientations. Although the ridges on the pediment surface may not directly correspond to this cross-bedding, the exposures are consistent with earlier interpretations that the linear features expressed on the surface record aeolian bedforms [2]. The pediment boundary between the capping unit and underlying

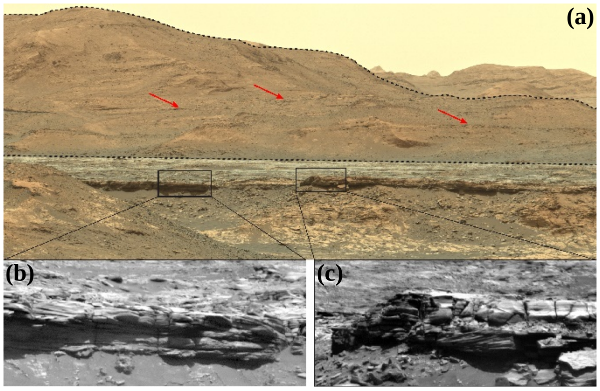


Fig. 2. Mastcam (MR_MCAM_12024) and Chemcam LD RMI (CCAM03984) images. **(a)** The GV ridge sediments above the pediment capping unit. Red arrows indicate sub-horizontal bedding. **(b, c)** Examples of crossbedding within the pediment capping unit. See also [8]

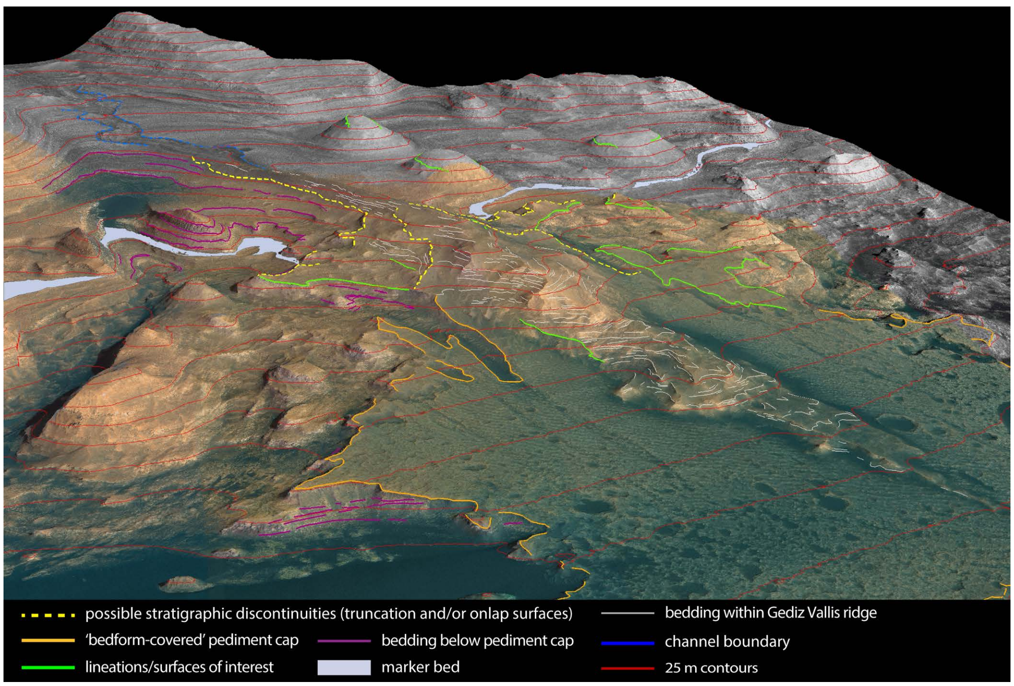


Fig. 3. Oblique view of Gediz Vallis region derived from color (lower portion) and gray-scale (upper portion) HiRISE images including mapped stratigraphy. Note 25 m contours and various stratigraphic and geomorphic features traced by colored lines.

strata (possibly the sulfate unit first reported by [7]) appears consistently sharp. The HiRISE images enable us to follow this boundary upslope and explore exposed stratigraphy below and above it. Note in the lower center of Fig. 3 where the underlying stratigraphy is sharply truncated by the pediment, consistent with the original proposal by [1, 9]. The underlying strata in this area appear to dip to the north, but much less steeply than the ~12^o slope of the pediment. The pediment surface (orange line) extends upslope to the thickest part of the GV ridge and then appears to be absent due to lateral erosion. A similar pattern is found on the west side. Additional surfaces that may record other erosional events are suggested by the traces noted by the dashed yellow lines. This also includes green lines marking the edges of smooth caps on isolated hill upslope and to the west of the pediment. The marker bed of [7] is well-exposed and mapped here (Fig 3. solid gray).

Gray lines delineate bedding that can be seen in the four distinct packages of sediment mapped by [3 and 4] in GV ridge: the lowest thin unit, the second with sharp ridges curved to the east (towards viewer), the lighter tone sharply elevated deposit with a steep erosion front, and then the highest darker tone unit that grades back to the inverted channel. The bedding in all four units within the GV ridge dip very gently relative to the pediment surface (Fig 3, gray lines). There is no indication of foreset beds in GV ridge. All four units appear to have boulder-rich beds, which show various shades of light and dark that my indicate lithologic heterogeneity.

The truncated, gently sloping beds of boulder-rich debris in GV ridge support the interpretation that the ridge is an the erosional remnant of a larger alluvial or debris flow fan. The exposures seen in HIRISE images do not definitively reveal whether the pediment surface formed around GV ridge or preceded its deposition. The future path of Curiosity will provide the necessary access to resolve sediment transport processes, stratigraphic relations, and thus the relative timing of the significant geologic events exposed in this landscape.

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