WHAT WAS THE ORIGINAL EXTENT OF THE GREENHEUGH PEDIMENT AND GEDIZ VALLIS RIDGE DEPOSITS IN GALE CRATER, MARS? 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. M. Fedo[5], V. K. Fox[2], S. Gupta[6], R. C. Wiens[7], R. M. E. Williams[8], R.E. Kronyak[5], K.W. Lewis[9], D.M. Rubin[10], W. N. Rapin[2], L. Le Deit[11], S. Le Mouélic[11], K. S. Edgett[12],A. A. Fraeman[3], S. G. Banham[6] M. N. Hughes[4], L. C. Kah[5]. [1]University of California, Berkeley, CA (bryk@berkeley.edu). [2]Division of Geological & Planetary Sciences, Caltech, Pasadena, CA. [3]Jet Propulsion Laboratory, Caltech, Pasadena, CA [4]Washington University in St. Louis, St. Louis, MO. [5]University of Tennessee, Knoxville, TN. [6]Imperial College, London, UK. [7]Los Alamos National Laboratory (LANL), Los Alamos, NM. [8]Planetary Science Institute, Tucson, AZ., [9]Johns Hopkins University, Baltimore, MD. [10]University of California, Santa Cruz. [11]Université de Nantes. [12]Malin Space Science Systems, San Diego, California.

Introduction: The Greenheugh pediment and Gediz Vallis (GV) ridge at the base of northern Aeolis Mons (Mt. Sharp), features to be explored during the third extension of the MSL mission, are hypothesized to have been more aerially extensive in the past [1], with important implications for geomorphic, geologic, and climate history interpretations. We investigate using HiRISE-derived topography and rover-based images the possibility that the pediment and associated capping unit extended across Vera Rubin ridge several kilometers to the north. We further suggest two possible endmember conditions for the former extent of the Gediz Vallis ridge deposits.

Greenheugh pediment: A long-recognized landform on the lower slopes of Mt. Sharp, [1-5], now referred to as the Greenheugh pediment [12] consists of: 1) an erosional unconformity (as proposed by [2, 10] and mapped by [5,12]) truncating sediments of the lower Mt. Sharp group [8], and 2) a ~1m thick capping unit covered in well-organized relatively evenly spaced (~10 m) ridges **(Figs. 1 and 2)** [12]. As described by [12], the Greenheugh pediment is a distinct planar surface bordered by an arcuate erosional edge (**Fig.1**). It has been considered to be part of a "mound-skirting unit" [2, 13], and may correlate to the Stimson formation [5,6,7,11]. The recently completed Vera Rubin ridge (VRR) campaign has raised questions about the relationship between the pediment and the VRR. The planview trace of the northern edge of the pediment parallels the curvature of VRR (**Fig. 1**). Further to the north there are distinct mesas that appear to be capped by a dark-toned unit possibly the Stimson fm. (**Fig 3a,b; [5, 6]).** Here we explore whether simple projections of the pediment northward would unite the pediment, VRR, and the mesas.

Fig. 4 shows topographic profile A-A' (**Fig. 1**) with two hypothetical Greenheugh surface reconstructions extending from the distal end of the present Greenheugh pediment and terminating north of the floor-mound transition. The first is a linear extrapolation of the lowermost Greenheugh surface. The second is a polynomial interpolation that connects the pediment surface and a distal plateau. At the scale of these projections, it is assumed the Greenheugh surface roughly parallels the underlying unconformity.

Both the linear and nonlinear projections shown in **Fig. 4** intersect Pile and Lobster mesas within a few meters of the apparent contact between the butte-capping units and the underlying Murray fm. (**Fig. 3a,b**). These projections indicate that the unconformity, perhaps generated by pedimentation may have extended well north. They also suggest that the VRR surface exposures visited by the rover were just below this truncation surface.

Gediz Vallis ridge: The Gediz Vallis (GV) ridge extends nearly 2 km downslope from an inverted channel that originates as a boulder-chocked sinuous channel upslope in Gediz Vallis (**Fig 2**). At its thickest, the ridge stands ~70 m above the Greenheugh surface (**Fig. 2**). The ridge appears to be heterolithic, with a combination of boulder-rich and finer-grained (containing ~decimeter-scale bedding) deposits [12,14]. The GV ridge has been interpreted as an erosional remnant of a fan that once covered the current extent of the pediment (and its shape was defined by the current outline of the pediment) [2] Alternatively, the fan may comprise partially preserved coarser grained deposits that terminated in transient lakes [4]. The timing of deposition relative to the pediment remains unclear [1-5]. Recent stratigraphic mapping from HiRISE images suggests that bedding within the GV ridge is dominantly sub-horizontal [12]. The nearly flat-lying bedding invites two possible endmember reconstructions irrespective of the stratigraphic relationship between the GV ridge and the pediment: 1) The GV ridge is a remnant of a fan that once extended well beyond Vera Rubin Ridge; 2) The relatively flat lying deposits record the topsets of fan-delta(s) that prograded into proximal lacustrine environments [4].

Curiosity encountered a small patch of heterolithic, non-lithified cobbles on VRR that may record a more extensive fan deposit. More compelling information should come from the closer survey Curiosity will conduct of outcrop exposures at the distal end of the ridge. In particular, effort will be made to detect any evidence of foreset beds [4,9,12].

Exploration of GV ridge and Greenheugh pediment will allow us to evaluate previous interpretations that these landforms record major shifts in geomorphic, sediment transport, and climatic conditions in Gale.

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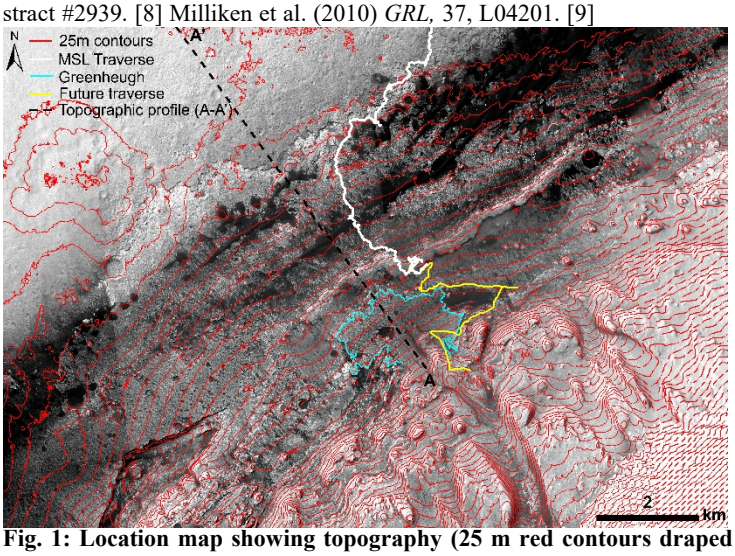

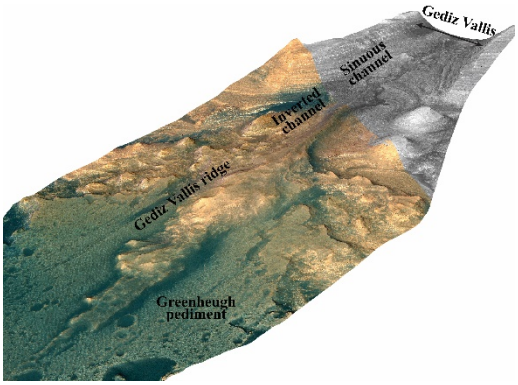

Fig. 2: View looking towards the southeast.

Fig. 1: Location map showing topography (25 m red contours draped on HiRISE image) ,MSL traverse (white to date, yellow in the future), pediment outline (blue) and topographic transect (black dashed line).

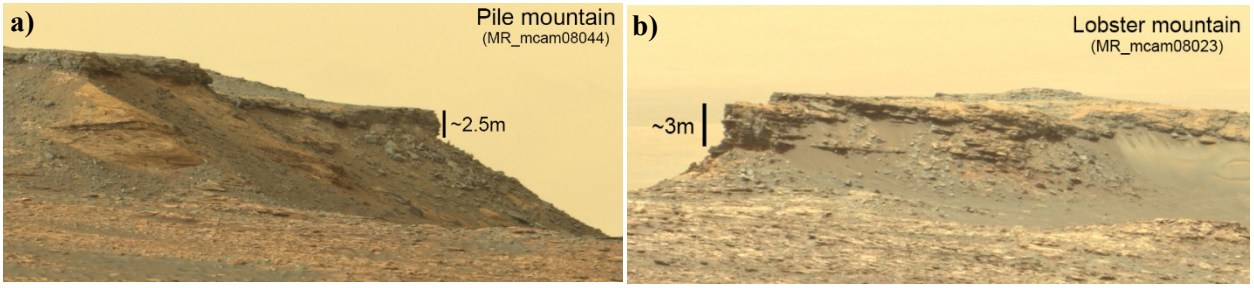

Fig. 3a,b Mesas encountered by Curiosity. Note the thick ~2-4m dark capping unit over Murray sediments.

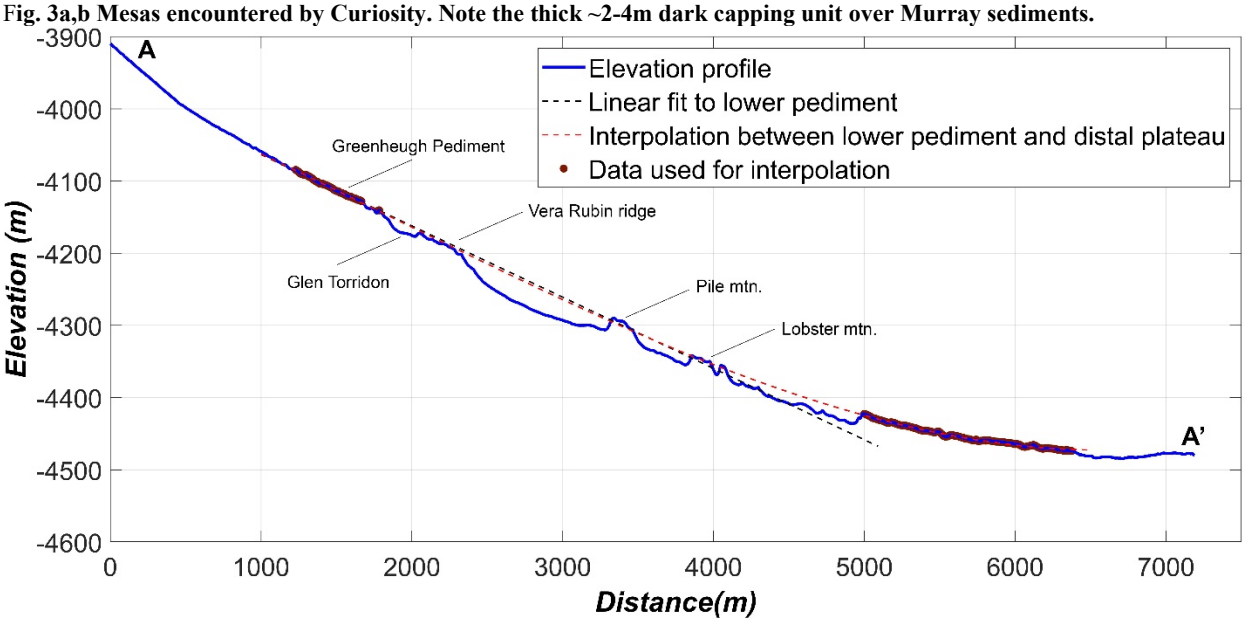

Fig. 4. Topographic profile A-A' (Fig. 1) with labeled locations and hypothetical reconstructions (linear and nonlinear fits) of the Greenheugh basal surface (unconformity).