**GEOLOGIC STRUCTURE OF THE VERA RUBIN RIDGE, GALE CRATER, MARS.** Kevin W. Lewis[1] and Madison L. Turner[1], [1]Dept. of Earth & Planetary Sciences, Johns Hopkins University, Baltimore, MD, USA (klewis@jhu.edu)

**Introduction** Aeolis Mons (Mount Sharp) is a 5 kilometer high mound of layered sedimentary rock within Gale crater on Mars, and is currently the field site of the Curiosity rover. The depositional, erosional, and diagenetic history of Mount Sharp is complex, involving prolonged and diverse geologic activity. Current studies suggest the lowermost stratigraphy is dominated by lacustrine deposition, transitioning to possible aeolian sedimentation in the upper units of the mound [1]. Multiple approaches have been used to interpret this history, including both physical (sedimentology, morphology, structure) and compositional (chemistry, mineralogy) data sets. Here, we focus on bedding orientation along the rover traverse, and its correspondence to previous orbital observations across the mound.

One of the most puzzling attributes of Mount Sharp is the orientation of layers exposed by erosion along the margins of the mound. Previous work has shown a surprising lack of horizontal stratigraphy, with layer dips oriented radially away from the center of the mound at wherever they have been measured [2]. Typical layer inclinations measured from HiRISE stereo topographic models range from 2–5 degrees from horizontal (Fig. 1). This structure is counter to expectations for most terrestrial sedimentary basins, where dips are typically shallow and oriented toward the center of the basin.

While measurements of layer orientation from orbital data can be made over long baselines ($\sim 100s$ m), providing high precision, only the most prominent layers can be reliably identified. In contrast stereo topographic

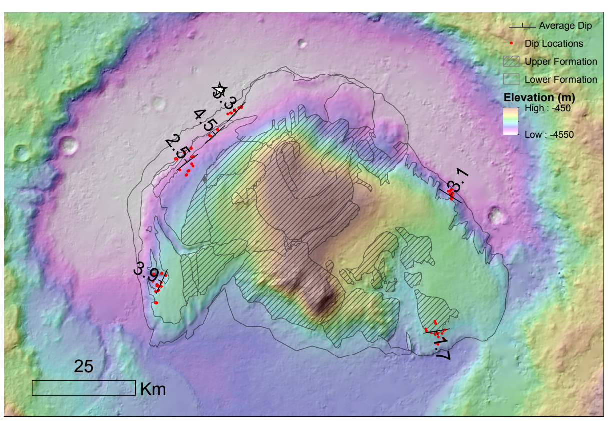


Figure 1: Average bedding orientation of several sites around the margin of Mount Sharp as measured from orbital HiRISE stereo topographic data, as described in [2].

data from the Curiosity rover can interrogate finer-scale bedding geometry over much smaller baselines. Due to the massive appearance of the lowermost Mount Sharp stratigraphy from orbit, the hematite-rich Vera Rubin ridge [3] represents one of the first sites along the Curiosity traverse where in situ rover measurements can be directly compared to HiRISE-derived data. Here we evaluate the correspondence between these two data sets.

**Methods** This study uses stereo image data from the Curiosity Navigation cameras (Navcams) and its Mast Cameras (Mastcams), each with a stereo baseline of several tens of centimeters. We use a number of stereo mosaics acquired from sol 1800 to the present where the distance to the outcrop is small ($<$10–15 meters), providing more accurate stereo ranging. We focused on larger intact rock outcrops to avoid bias from individual eroded blocks that may have been rotated since deposition. Figure 2 shows in blue the sites where image mosaics of the Vera Rubin ridge bedrock met these conditions. Layers were traced on the original Mastcam images, and the corresponding topographic data $[x, y, z]$ are extracted at each image pixel. The dip and dip azimuth of each layer is calculated by fitting a planar surface to the extracted points via ordinary linear regression [4]. For the rover data use in this study, the regression is performed in a rotated coordinate system $[x', y', z']$, where $z'$ is along the camera optical axis for each image. This serves to minimize residuals oriented along the error (range) direction of the topographic data.

**Results** In total, we collected over 450 measurements of individual layers across the Vera Rubin ridge over 16 sites. We use an angular regression error threshold to reject layers that are poorly fit by planar surfaces. Figure 3 shows the dip and dip azimuths of those layers passing a 1 or 2 degree threshold. The average orientation of these layers is shown in blue, oriented to the northwest with a mean dip of $3.4 \pm 0.8°$. Broadly, this value is consistent with the orbitally-derived dips on the northwest quadrant of Mount Sharp from [2], shown in Figure 1. Although Murray formation within the Vera Rubin ridge is dominated by planar-laminated sediments, we observe a broad spread of layer orientations within the rover-derived data set - in contrast to orbital measurements. In some cases, this can be attributed to localized deformation around small impact structures. These are relatively common on the surface of the resistant ridge relative to more easily eroded sections of the Murray formation traversed by Curiosity.

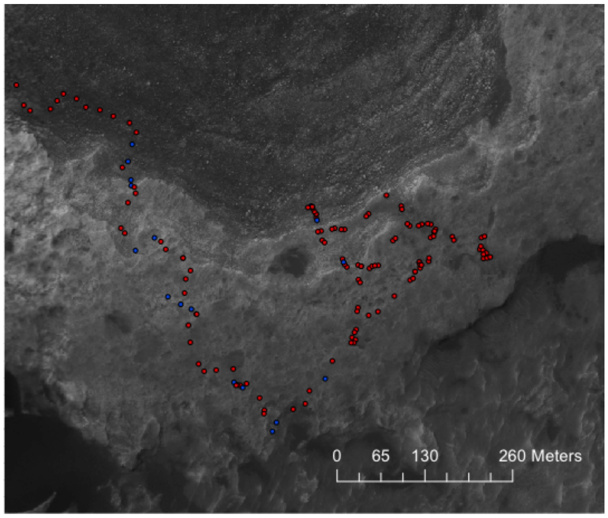


Figure 2: Map of the Curiosity traverse (red) onto and across the Vera Rubin ridge of Mount Sharp. Blue markers show locations where bedding orientations can be measured from rover stereo topographic data.

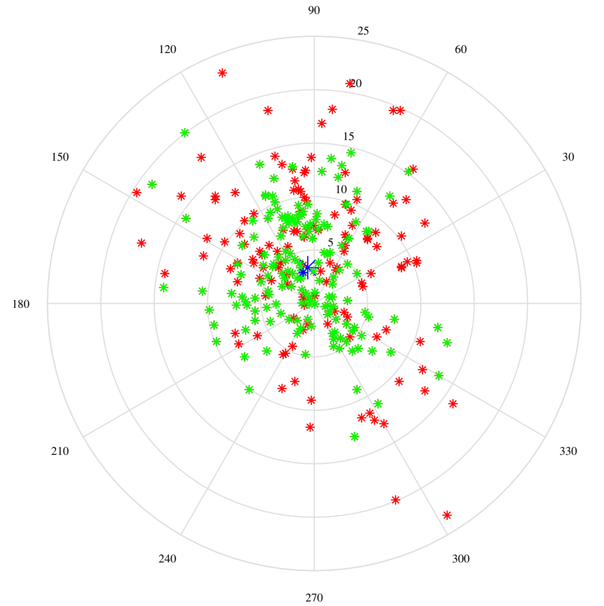


Figure 3: Polar plot of nearly 300 layer dip measurements on the Vera Rubin ridge from Curiosity image data using two different error thresholds (green=1°, red=2°). The mean tilt of the layers is $3.4 \pm 0.8°$ to the northwest, consistent with orbital measurements.

Overall, these data provide the first ground-truth validation of previous orbitally-derived structure measurements at Mount Sharp. Mastcam and Navcam stereo topographic data support the observation that the mound exhibits dips oriented radially-outward, in this case to the northwest. The origin of this pattern remains uncertain, and has been proposed to arise from either aeolian deposition patterns driven by slope winds [2] or from post-depositional sediment compaction [1]. The ability to investigate these structural trends at a variety of scales may provide a better understanding of its origin. Further refinement of bedding attitudes along the traverse are critical in determining the relative stratigraphic position of scientific targets observed by the rover.

## References

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