GEOLOGIC MAPPING AND STRATIGRAPHIC ANALYSIS OF THE "CLAY TROUGH" OF MOUNT SHARP, GALE CRATER, MARS. S. Cofield,[1] K. M. Stack[2] and A. A. Fraeman,[2] [1]Old Dominion University, Norfolk, VA, 23529, scofi002@odu.edu, [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109.

Introduction: During its extended mission phase, the Mars Science Laboratory (MSL) Curiosity rover mission is exploring the stratigrapy of lower Mount Sharp, including the Murray formation, a hematite-bearing ridge, a trough containing clay mineral signatures, and overlying sulfate-bearing layers [1]. Previous studies using orbital images and spectral data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) to map Gale crater have depicted the clay-bearing trough as a single mapped unit [1-4], but uncertainties about the stratigraphic context of this clay-bearing interval within Mount Sharp persist..

In this study, we constructed a 1:500 scale geologic orbital map of the clay trough as part of a [5]'s effort to map Curiosity's extended mission traverse using images and digital terrain models (DTMs) from the High Resolution Imaging Science Experiment (HiRISE) camera. We used this map and interpretive cross-sections to: (1) test stratigraphic models for the clay-bearing unit, (2) reveal the presence of multiple mappable units within the clay trough, and (3) provide suggestions for scientific targets of interest for the Curiosity rover to explore within the clay trough.

Methods: The 3 km^2 study area spans the proposed traverse of MSL Curiosity rover's extended mission across the hematite-bearing ridge and the clay-bearing trough (Fig. 1). Units were identified by texture, brightness, and layering style on a HiRISE mosaic (~0.25 m/pixel) paired with a Digital Terrain Model (DTM; ~1 m/pixel). The orbital geologic map constructed here was compared to CRISM spectral parameter maps from [4] and [6] to determine the distribution of mineral signatures relative to mapped units.

Units: Units are grouped by location within the study area:

Ridge. Two units were mapped as part of the ridge overlying polygonally fractured bedrock of the Murray formation to the north. The lower ridge unit exhibits a mottled texture of variable tone, while the upper ridge ridge unit forms a higher elevation cap exhibiting a smooth texture and uniform tone.

Clay trough. The clay trough is composed of two main units. The smooth ridged unit is characterized by a smooth texture, uniform tone, and the presence of NE/SW trending ridges interpreted to be erosional features (Figure 2). The presence of eroded ridges and the preservation of occasional small impact craters suggest that this unit is indurated. Amongst the smooth ridged unit are exposures of bedrock exhibiting polygonal fracture patterns at a variety of scales. Polygonally fractured bedrock within the trough is further grouped by average polygon sizes, <1.0 m, up to 5.5 m, and >5.0 m. Although the relative age relationship between the smooth ridged unit and the polygonal bedrock units within the clay trough is ambiguous throughout much of the area, an interbedding relationship is observed in the western portion of the mapping area.

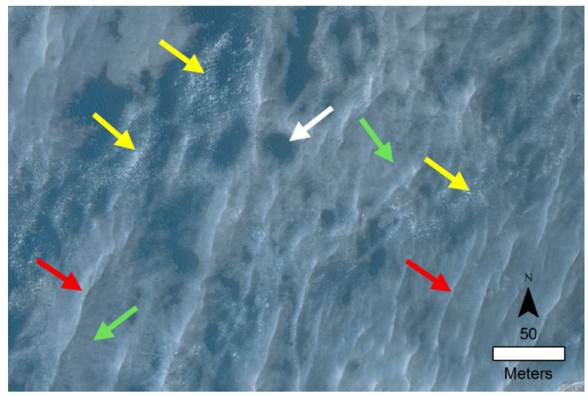
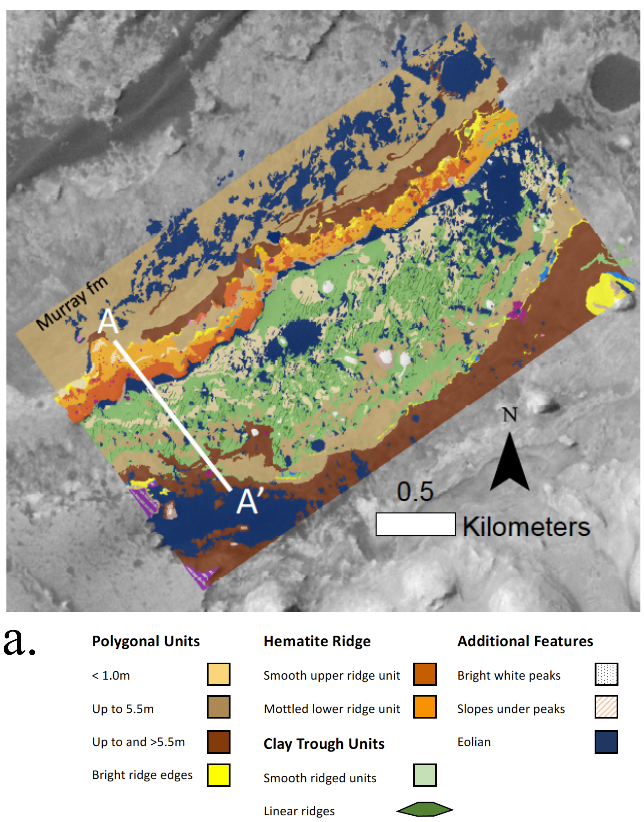


Figure 2. HiRISE example of clay trough units: Smooth ridged unit (green arrows), linear ridges (red arrows), polygonally fractured bedrock (yellow arrows), and eolian features (white arrow).

Additional mapped units and features. Upsection from the clay trough is a polygonally fractured bedrock unit that does not appear to contain smooth interbeds. Modern aeolian sand dunes (dark/ black color), large craters (sharp geologic boundaries), and bright mounds were also mapped.

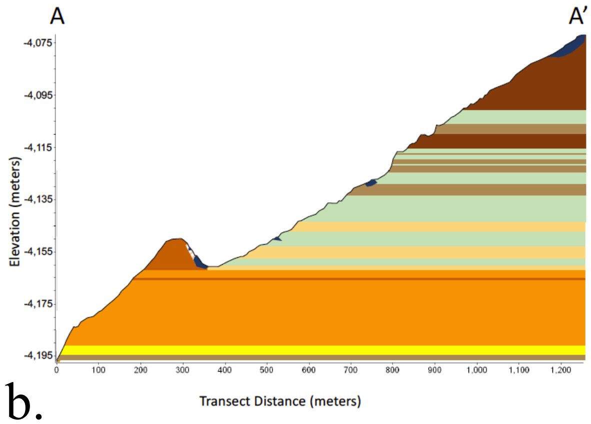
Comparison with CRISM spectral parameter mapping: The distribution of hematite in spectral parameter maps produced by [4] reveals that signatures are strongest near the top of the ridge, coinciding best with the mapped disitribution of the mottled lower ridge unit. Despite the presence of two distinct units mapped here within the clay trough, the phyllosilicate signature mapped by [5] appears largely uniform over this area indicating that clay minerals may be present in both units, or that clay-bearing materials weathering from one of the units has formed a thin mantle throughout the entire area. Updated parameter maps produced from along track oversampled CRISM observations by [6] suggest that the clay signature may best correlates with the clay trough smooth ridged unit mapped here. Curiosity rover analyses of both units within the clay trough could resolve whether one or both units are clay-bearing.

Stratigraphic Analysis: Cross-sections constructed across the clay trough reveal a pattern of interbedded polygonal fractured bedrock with the smooth ridged unit (Fig. 4). If the smooth ridged unit is the source of the clay minerals observed with CRISM, a stratigraphic model in which thin intervals of clay-bearing strata are interbedded with non-clay-bearing bedrock is most consistent with the observations made here (Fig. 1B). However, the smooth ridged unit, whether clay-bearing or not, does not appear to crop out along the northern face of the ridge as might be expected if this unit was a laterally extensive, through-going unit within the stratigraphy. Interpreting the strata within this interval with an ~6º dip, as measured in [4], still indicates that the units mapped within the clay trough should project downslope to be exposed at the surface north of the ridge (Figure 1C). Therefore, we favor a model in which the smooth ridged unit of the clay trough pinches out laterally downslope, perhaps due to facies transitions within Mount Sharp. If the smooth ridge unit is indeed clay-bearing, a pinch-out could explain why strong smectite signals are not observed north of the ridge.

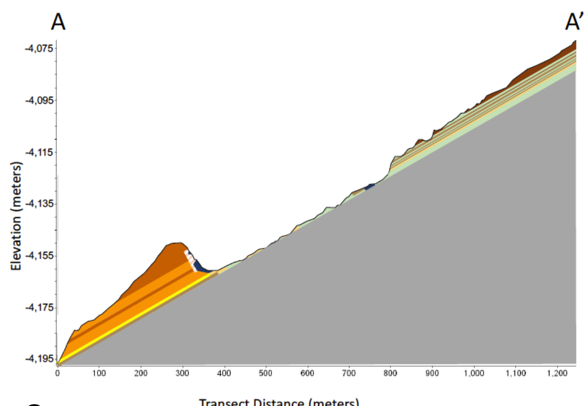


a.

References: [1] Grotzinger et al. (2015), *Science, 350,* 6257, aac7575. [2] Anderson R. C. and Bell III, J. F. (1997) *Mars, 5,* 76-128. [3] Edgett K. S. and Malin M. C. (2001, March) *LPSC 30,* Abstract# 1005. [4] Fraeman A. A. at al. (2016) *JGR-Planets, 121(9)*, 1713-1736. [5] Stack et al. (2017), *LPSC 48*, this meeting. [6] V. K. Fox et al. (2017) *JGR-Planets, 121(9),* 1713-1736.



b.



c.

Figure 1. (a) HiRISE orbital image-based geologic map of the hematite-bearing ridge and clay-bearing trough of the MSL Curiosity rover extended mission traverse. White line identifies cross-section transect detailed in (b) and (c). (b) Cross-section A to A’ assuming horizontal dip. (c) Cross-section A to A’ assuming ~6º dip. VE = 9.4x