GEOLOGIC MAPPING OF NORTHWESTERN AEOLIS MONS, GALE CRATER, MARS: CONTEXT FOR THE MARS SCIENCE LABORATORY EXTENDED MISSION TRAVERSE. L. A. Edgar[1], F. J. Calef[2], and B. J. Thomson[3], Ryan B. Anderson[1] [1]USGS Astrogeology Science Center, Flagstaff, AZ (ledgar@usgs.gov), [2]NASA Jet Propulsion Laboratory-Caltech, Pasadena, CA, [3]University of Tennessee, Knoxville, TN.

Introduction: Aeolis Mons, the central mound of Gale crater, contains a thick succession of intact stratigraphy, inferred to record changes in aqueous and climatic conditions during a key transition in Mars' history. These changes are documented in a variety of textural and mineralogic properties that are associated with distinct stratigraphic levels of the mound. The opportunity to study the mound stratigraphy, and the environmental changes recorded within it, led to Gale's selection as the landing site for the Mars Science Laboratory (MSL) mission [1].

Gale crater has been the target of multiple studies aimed at understanding the origin and evolution of the mound, informally known as Mt. Sharp. A number of efforts have produced geologic maps of the mound and the MSL landing ellipse, in order to investigate the stratigraphic relationships between different sedimentary units [e.g., 2–6]. These studies have occurred across a variety of scales and spatial extents, and reveal that Gale crater has a rich sedimentary history. There exists, however, a scale gap between local mapping and stratigraphic analyses of the landing ellipse and regional mapping of Aeolis Mons. As Curiosity explores the northwest flank of Aeolis Mons, there is a critical need for investigations to bridge this gap to enable rover-scale observations to be tied to orbital interpretations. This study is focused on the production of 1:10,000-scale geologic map and stratigraphic correlations for the northwest flank of Mt. Sharp, including an area that the Curiosity rover will likely explore.

Background: In an effort to understand the origin and evolution of Aeolis Mons, several studies have produced geologic maps of the mound and landing ellipse, covering a range of scales and spatial extents. [2] produced a map of the landing ellipse and lower mound based primarily on 6 m/pixel CTX images. [3] mapped the central mound at a scale of 1:50,000. [4] used HiRISE images to create a geologic map of the landing ellipse and surrounding areas at approximately 1:10,000 scale. More recently, [5] produced a high-resolution geologic map for part of the lower mound at 1:500 scale, focusing on the rover's intended traverse path. These studies have shown that Gale has a complex geologic history, and they also highlight the benefits of map products at multiple scales to provide both local and regional context. However, there does not currently exist a detailed (1:10,000-scale) map of the lower mound, to provide context for Curiosity's extended mission traverse.

Here we report on initial results from a geologic mapping study that is intended to bridge these previous and ongoing efforts. The study region encompasses much of the lower mound stratigraphy, including the contact between the upper and lower mound units, and it is continuous with previous detailed mapping efforts of the landing ellipse (**Fig. 1**). The map region also covers the channel and fan that the Curiosity rover might eventually explore.

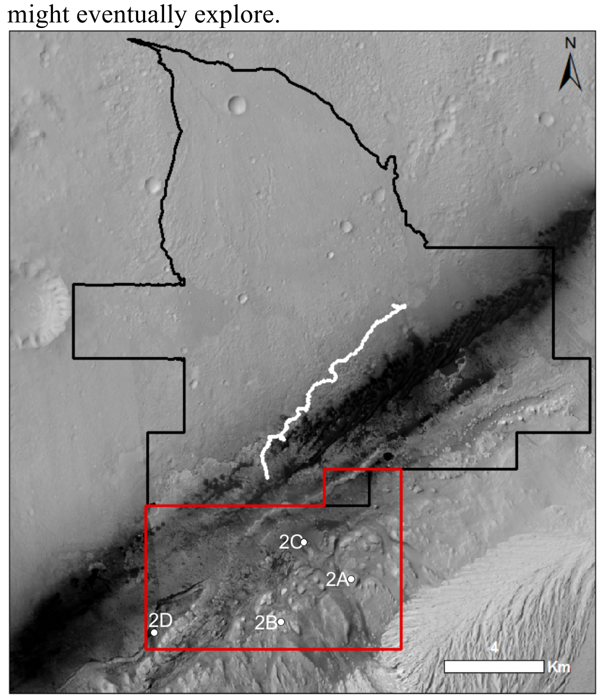

Figure 1. Red box represents the current map area, covering a large portion of the northwestern flank of Aeolis Mons. Black outlines the prior mapping efforts focused on the MSL landing ellipse [4]. White line gives Curiosity's traverse path as of Sol 1555. Numbered points show the location of images in Figure 2.

Datasets and Methods: This investigation focuses on constructing a 1:10,000-scale geologic map of northwestern Aeolis Mons. The study region covers a 5.8 × 10 km area from approximately 137.27 to 137.44 °E and –4.70 to –4.82 °N. A recently released 25 cm/pixel mosaic produced from images acquired by the High Resolution Imaging Science Experiment (HiRISE) camera provides a basemap for all mapping [7]. Topographic information is provided by a HiRISE 1 m Digital Terrain Model [7]. Preliminary geologic contacts were identified at a scale of 1:10,000 to provide a framework for group mapping efforts. More detailed mapping is being conducted at a digital scale of 1:2,000 using Esri ArcGIS® software.

Results: Initial mapping has resulted in the identification of a variety of geologic units, which can be divided into four distinct groups: stratified units, massive units, ridge and fan units, and surficial units.

Stratified units: The stratified units of the lower mound are characterized by light-toned, well-stratified planar deposits (**Fig. 2A)** that can be traced across much of the study region. Variations in albedo and weathering style enable the distinction of several stratigraphic units. A smooth, dark-toned planar bed that retains impact craters can be used to separate stratigraphic packages. This surface may correspond to the marker-bed identified by [8] to represent the boundary between the middle and upper members of the Lower formation. Stratified units can be subdivided into rugged layered units that are a few meters in thickness, and smooth layered units with bedding that is 1-5 m thick and weathers into sub-meter to decimeter scale blocks.

Massive units: The upper part of the Lower formation is characterized by massive, resistant, mesa-forming units (**Fig. 2B**). These mesas create significant relief and retain impact craters. These units generally have a higher albedo than the underlying well-stratified units. The massive, mesa-forming units are defined by blocky units with little to no stratification that are often tens of meters thick, and form a series of buttes and ridges.

Ridge and fan units: Two of the most prominent features in the study region are a ridge with a strong hematite signature [e.g., 9] and a filled channel and fan (**Fig. 2C**). These geomorphic features also correspond to discrete geologic units. The ~10 m high ridge is characterized as resistant and sinuous, lightly fractured, with no meter-scale blocks. Low meter-scale roughness is variably eroded away to expose a smooth massive unit below. The fan units consist of heavily cratered fan-shaped surfaces overlain by a blocky, resistant, ridge-forming unit that connects to a filled channel, pointing to multiple episodes of deposition.

Surficial Deposits: The northwest flank of Aeolis Mons is covered by a variety of surficial units. Surficial deposits include eolian bedforms and smooth units located on eroded slopes (**Fig. 2D**). Bedforms are evenly spaced and occur mostly in topographic lows and are bounded by topographic barriers. Smooth units are dark-toned and found on eroded slopes and flat benches. Surficial units are interpreted as the product of eolian and mass-wasting processes. The absence of impact craters in most surficial units suggests that these are the product of relatively young and potentially still active processes (consistent with MSL measurement of cosmic ray exposure ages within Gale [10]).

Summary: Preliminary mapping work reveals diverse geologic units exposed on the northwest flank of Aeolis Mons. This study bridges the gap between previous mapping scales, and will enable rover-scale observations to be tied to orbital interpretations. Through detailed geologic mapping we have identified a number of new units in the lower mound that may indicate more variability in the depositional and erosional history than previously identified.

Future Work: The next steps are included here:

- Complete 1:2,000-scale geologic mapping.
- Identify geologic type localities and construct stratigraphic sections.
- Compile geologic history that places localized observations into a broader, standardized context for comparison to other mapping studies and observations from the Curiosity rover.

References: [1] Golombek M. et al. (2012) *SSR, 170*, 641-737. [2] Anderson, R.B. and Bell, J.F. III. (2010), *Mars J., 5*, 76-128. [3] Thomson B.J. et al. (2011) *Icarus 214*(2), 413-432. [4] Calef III, F.J. et al. (2013) *LPS XLIV,* Abstract #2511. [5] Stack, K.M. et al. (2016) *GSA* Paper No. 80-6. [6] Le Deit, L. et al. (2013) *JGR 118*(12), 2439-2473. [7] Calef III, F.J. and Parker, T. (2016) *PDS Annex USGS*, http://bit.ly/MSL_Basemap. [8] Milliken, R.E. et al. (2010) *GRL, 37*(4). [9] Fraeman, A.A., et al. (2013) *Geology 41*(10), 1103–1106. [10] Farley et al. (2014) *Science, 343*(6169), 1247166-1.

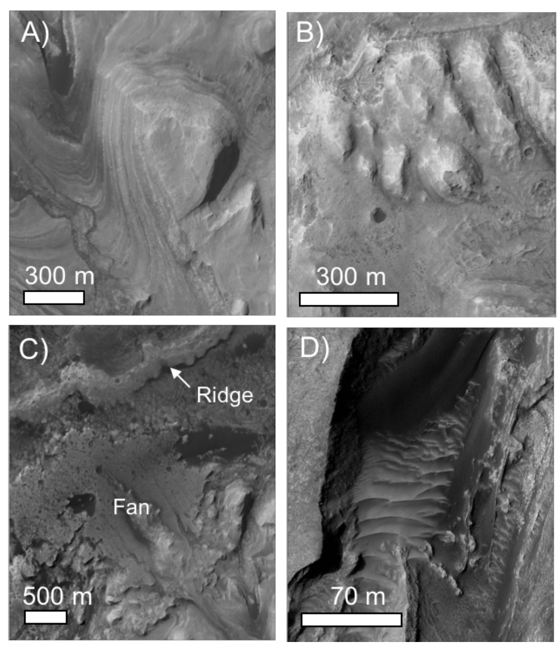

Figure 2. Examples of A) stratified units, B) Mesa-forming units, C) Ridge and Fan units, and D) Surficial deposits.