

Stratigraphy of Olivine–Carbonate–Bearing Units Forming Mesas and Linear Features in Northeast Syrtis Major: Implications for Emplacement

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Introduction The Northeast Syrtis Major region of Mars features a diverse set of geologic units where the exposed stratigraphy has distinct units hosting phyllosilicates, carbonates, and sulfates [1,2], likely recording the chemical evolution of waters towards acidic pH [2], and hosts distinct ridge networks that possibly served as conduits for fluid flow [3]. We are investigating the detailed stratigraphy of Northeast Syrtis Major (Fig. 1) to understand the spatial and temporal relationship of the mafic unit variably altered to carbonate [2,4]. These olivine–carbonate–bearing units identified via CRISM analysis (see abstract) are observed to correlate with spatially extensive exposures forming mesa units (Fig. 2), long linear features, and extensive basal units. These units likely correlate with regional olivine exposures [1,5,6], and here we investigate their morphology and provenance utilizing high resolution datasets.

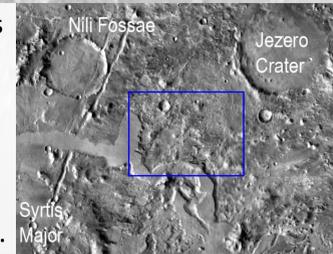
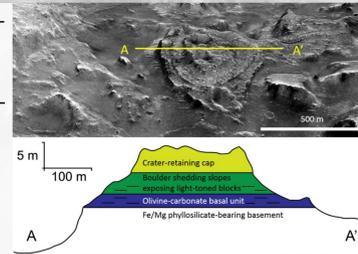


Figure 1: THEMIS Day IR context map (left) with the study region shown in blue. **Figure 2:** HiRISE digital elevation model (DEM) perspective view of a Mesa Forming Unit (right) with profile A-A' showing the relationship of the three components.



Mesa Forming Unit (MFU) The MFU is defined by three properties: **(1)** An uppermost rough, corrugated, crater-preserving surface. **(2)** A middle unit of dark-toned slopes shedding both light and dark-toned boulders variably exposing larger light-toned blocks. Some mesas display banding in this middle unit and/or a lack of boulder shedding. **(3)** A lowermost extensive basal unit surrounding the mesa, and frequently extending beyond the vertical extent of the mesa. Light-toned blocks of various sizes are seen closely packed in this component amongst a darker matrix, and a sharp contact is seen with neighboring units. Variable banding is observed in the lowermost unit. These mesas likely correlate those seen throughout the region [1,2,4,7] and appear in the study area in various states of erosion (Fig. 3).

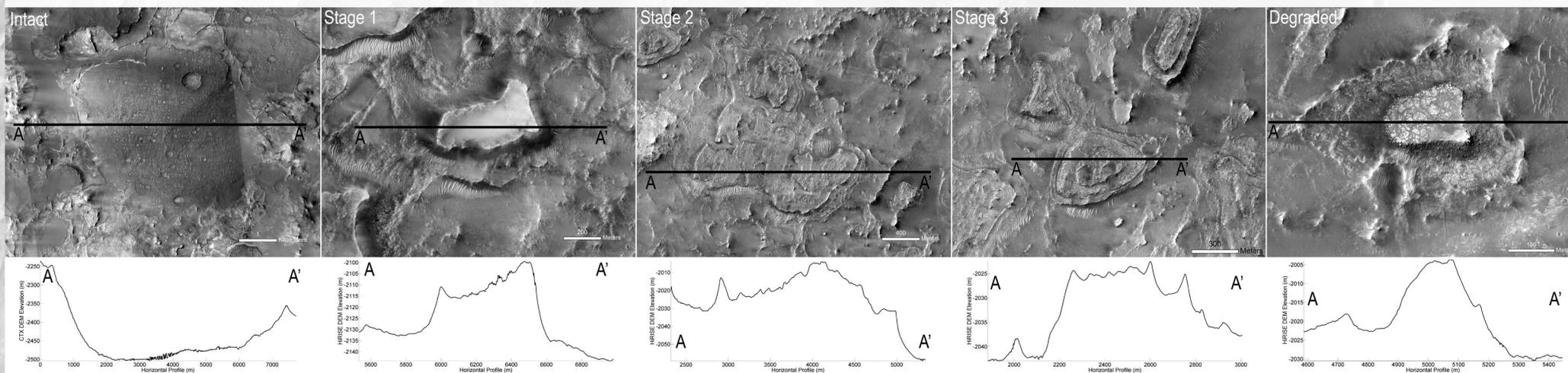


Figure 3: (left) MFU depicting the various states of degradation with CTX/HiRISE DEM elevation.

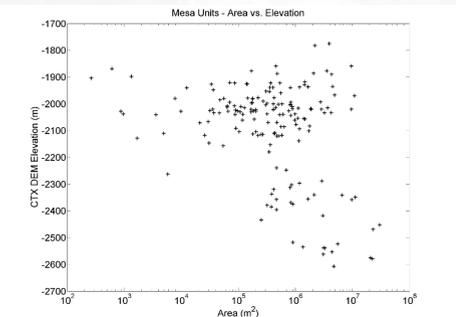


Figure 4: (above) Mesa elevation vs. mesa area for Northeast Syrtis Major.

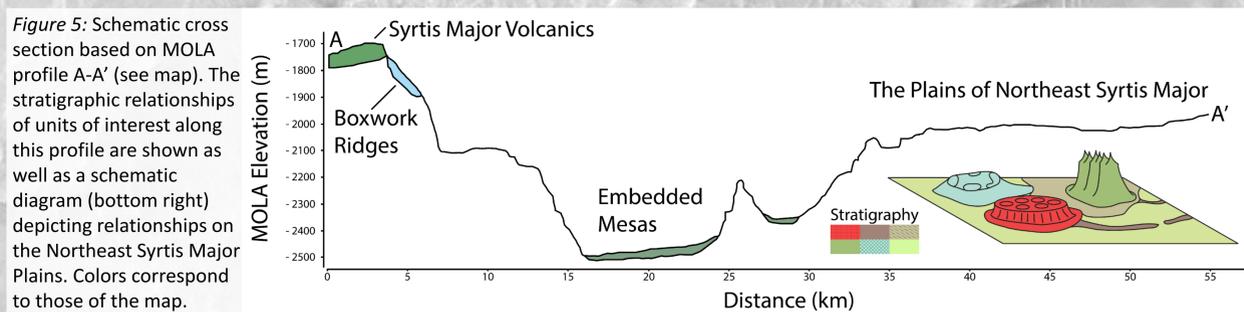


Figure 5: Schematic cross section based on MOLA profile A-A' (see map). The stratigraphic relationships of units of interest along this profile are shown as well as a schematic diagram (bottom right) depicting relationships on the Northeast Syrtis Major Plains. Colors correspond to those of the map.

Findings **(1)** Extensive coverage of the olivine-carbonate unit, from the Syrtis Major Volcanics to the southwest rim of Jezero Crater. **(2)** The olivine-carbonate unit, in the form of the MFU, LLF, and Extensive Basal Unit, is the highest stratigraphic unit but not always the topographically highest. It postdates the formation of Isidis, but predates the emplacement of the Syrtis Major Volcanics. **(3)** Mesas are present in various erosional states with the least eroded at the lowest elevations and vice versa (Fig. 4).

References: [1] Mustard J. F. et al. (2009) *JGR*, 114, E00D12. [2] Ehlmann B. L. and Mustard J. F. (2012) *GRL*, 39, L11202. [3] Saper L. and Mustard J. F. (2013) *GRL*, 40, 245–249. [4] Mustard J. F. and Wiseman S. M. (2014) *LPS XLV*, Abstract #2583. [5] Mustard J. F. et al. (2007) *JGR*, 112, E08S03. [6] Tornabene L. L. et al. (2008) *JGR*, 113, E10001. [7] Ehlmann B. L. et al. (2008) *Science*, 322, 1828–1832. [8] Broxton M. J. and Edwards L. J. (2008) *LPS XXXIX*, Abstract #2419. [9] Moratto Z. M. et al. (2010) *LPS XLI*, Abstract #2364.

Long Linear Features (LLF) The LLF have the following properties: **(1)** 10s to 100s of m wide and 1000s of m long and observed throughout the study region (Figs. 6–7). **(2)** Intimately related to the MFU and the Extensive Basal Unit as they join seamlessly with edges of these units and share the same olivine-carbonate CRISM spectral signature. **(3)** The material is light-toned and blocky, and the LLF are commonly bounded by raised rims. **(4)** Appear to follow the topography and are sometimes exposed as raised ridges or recessive troughs.

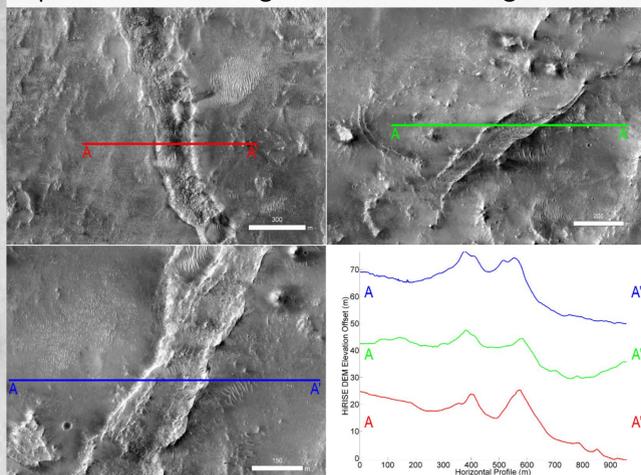
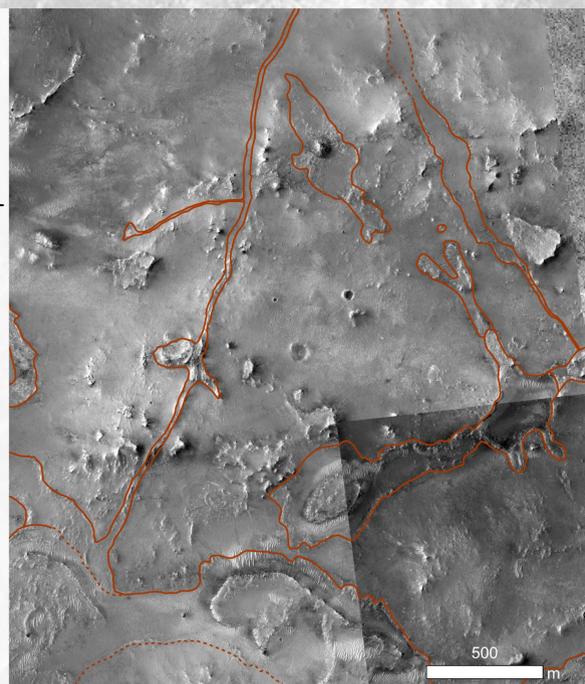


Figure 6: (above) LLF showing relationships with MFU. **Figure 7:** (left) HiRISE subframes depicting three LLF. A HiRISE DEM elevation profile for each is included showing the raised bounding ridges.

Morphological Mapping of Northeast Syrtis Major Morpho-geological mapping is being performed through a synthesis of the available HiRISE and CTX imagery and derived stereo elevation products [8,9]. Continued mapping will focus on the western portion and deciphering currently undifferentiated geological units in CTX images. MOLA profile A-A' in Figure 5 is shown. Scale: 1:150,000

