SOUTH OF MAWRTH VALLIS: A POTENTIAL FUTURE LANDING SITE WITH EXTENSIVE EXPOSURES OF THE MAWRTH VALLIS STRATIGRAPHY.
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Introduction: The Mawrth Vallis region, centered near 24° N, 341° E, was one of the final four areas considered as a landing site for the Mars Science Laboratory (MSL). The Mawrth Vallis region was of great interest as a possible MSL landing site since it has the greatest areal exposures of phyllosilicate-bearing layered rocks on the surface of Mars and is considered among the oldest exposures of such terrains [1,2]. The region consists of a distinctive stratigraphy which, at its most basic, consists of Fe/Mg smectite bearing rocks overlain by Al phyllosilicate-bearing rocks [3]. With the selection of Gale Crater as the MSL landing site, the opportunity for a near term landed investigation of this stratigraphy was lost. While plans for future landed science missions are in flux, one possible constraint of a future landed science mission, if the mission were to utilize a solar-powered rover, would be for it to land at a site south of 20° N latitude. The most extensive exposures of the Mawrth Vallis stratigraphy lie north of 20°; however, as noted by [4] there are exposures of this stratigraphy in the greater Arabia Terra region. In this work we report on an extensive exposure of the Mawrth Vallis stratigraphy that lies to the south of the Mawrth Vallis channel, centered at approximately 19.7° N, 342.6° E (**Fig. 1**).

Geologic setting: The Mawrth Vallis stratigraphy, as noted by a number of other workers, consists of an approximately 200 m thick sequence of phyllosilicate-bearing layered rocks. In this stratigraphy, a basal Fe/Mg smectite-bearing unit is overlain by a thinner Al phyllosilicate – bearing unit that includes montmorillonite, kaolinite (and related minerals), and hydrated silica. Between these two major units is a transitional stage with some phase that has a broad near infrared absorption that is largely consistent with some ferrous micas and/or chlorites [3]. Recent work also indicates that there are scattered occurences of sulfates at the top of the Mawrth Vallis section [5, 6]. Also of interest in the region, and very prominent throughout the southern area discussed here, are a number of inverted topography features, both channels and craters. The fluvial channels were likely formed after, or potentially during the deposition of the Al phyllosilicate layers. The bulk of the deposition of the phyllosilicate minerals likely took place in the late Noachian with the latest stages potentially occurring in the early Hesperian.

Suitability as a landing site: The light-toned areas in **Fig. 1**, representing the phyllosilicate-bearing material, have MOLA-derived slopes of 0 to 3.5°. A smoother area is the mantled area to the east-southeast (dark-toned area, with a central closed contour, in the center of **Fig. 2**) which has slopes of 1° or less.

Features of interest: The smooth area noted above, and shown in **Fig. 2**, also represents a mild topographic depression and, indeed, inverted channels to the north converge on this ellipsoidal depression. Thus, while mantled, the area very likely hosts relatively late-stage sedimentary materials.

The Mawrth Vallis stratigraphy exposed in this region provides ample opportunity to explore the breadth

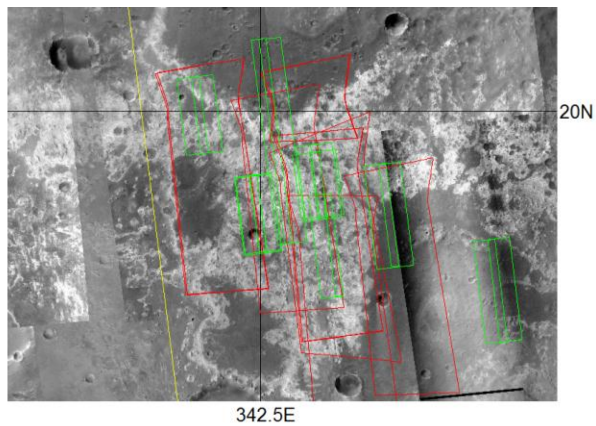

Fig. 1. GIS map with outlines of CRISM and HiRISE datasets covering the proposed landing site area.

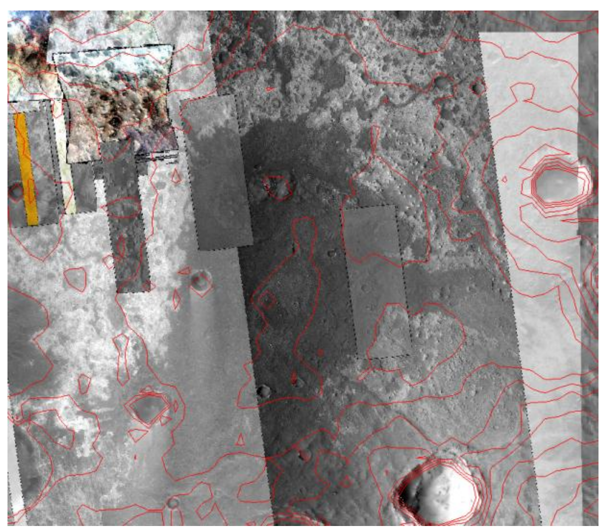

Fig. 2. GIS map with CRISM and HiRISE scenes overlaid in upper left and MOLA contours centered on shallow basin noted in text.

of that stratigraphy. There are large expanses of the Fe/Mg smectite unit with more limited exposures of the Al phyllosilicate unit. Also, the Fe/Mg smectites exposed in this region are, in many locations more Mg-rich (as indicated by a band minimum at 2.3 rather than 2.29 μm) than the bulk of the Fe/Mg smectites exposed in the more extensive exposures to the north.

This area also provides excellent examples of multiple episodes of deposition of Fe/Mg smectite-bearing materials. For example, the HiRISE view in **Fig. 3** shows a hill and concentric exposures surrounding it of light-toned Fe/Mg smectite-bearing rocks (**Fig. 4**). These are surrounded by darker-toned material, also with the Fe/Mg smectite signature, which, in turn, have circular features, ostensibly ancient craters, also filled with the Fe/Mg smectite bearing material.

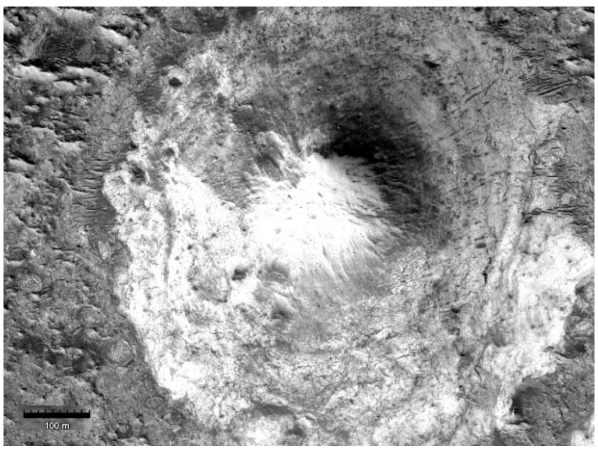

Fig. 3. Reduced resolution subsection of HiRISE scene ESP_021866_2000 showing hill with apron of younger Fe/Mg smectite bearing material overlying older Fe/Mg smectite material. Scale bar in lower left is 100 m in length.

A CRISM spectrum of hills, such as those shown in **Fig. 3** and **4,** is presented in **Fig. 5.** This type of spectrum, with a positive 1 to 2 μm slope, has been associated with the ferrous micas or chlorites noted above [3]. These hills can also have an extensive dust cover and an associated high 530 nm band depth.

Value as a landing site: The area discussed here provides a well exposed set of outcrops of the Mawrth Vallis stratigraphic units including a sequence of Fe/Mg smectite bearing layered rocks of varying mineralogic composition (from more Fe-rich to more Mg-rich), deposited over a long period of time with hiatuses of deposition. These rocks give way to the overlying Al phyllosilicate unit (**Fig. 4**) which is also well exposed in the area as are more enigmatic, well indurated materials which might include ferrous micas and/or chlorites.

References: [1] Bibring et al. (2005) *Science*, **307**, 1591-1594. [2] Loizeau et al. (2007) *JGR*, **112**, 10.1029/2006JE002877. [3] Bishop et al. (2008) *Science*, **321**, doi: 10.1126/science.1159699. [4] Noe Dobrea et al. (2010) JGR, 115, 10.1029/2009JE003351. [5] Farrand et al. (2009) *Icarus*, **204**, 478-488. [6] Noe Dobrea et al. (2011) *Mars Journal, 6*, 10.1555/mars2011.0003.

Acknowledgements: This work was funded through a contract to the Jet Propulsion Laboratory for future landing site assessments. Thanks also to Eldar Noe Dobrea of PSI for assistance with CRISM atmospheric corrections.

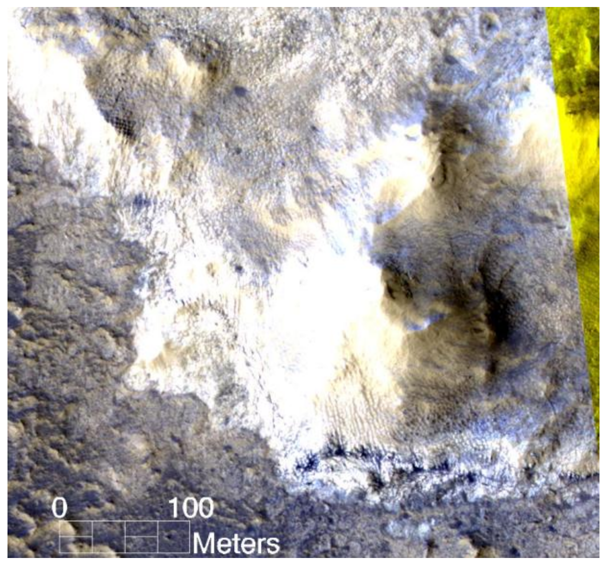

Fig. 4. Al phyllosilicate unit (lighter-toned, smaller fracture cells) overlying darker-toned Fe/Mg smectites.

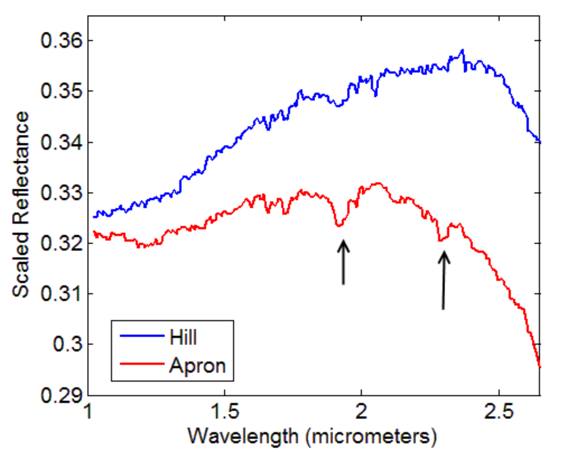

Fig. 5. CRISM spectra of hills in region (blue) and apron shown in **Fig. 3**. Arrows indicate 1.9 and 2.3 μm absorption bands.