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Stratigraphy of the clay-unit at Mawrth Vallis, Mars

D. Loizeau (1), N. Mangold (2), J. Grant (3), V. Ansan (2) and J.-P. Bibring (4)
(1) ESTEC-ESA, The Netherlands, (2) Université de Nantes, France, (3) Smithsonian National Air and Space Museum, Washington DC, USA, (4) Université Paris-Sud XI, France (damien.loizeau@esa.int)

Abstract

The plateaus of Mawrth Vallis show thin layers over a >200 m thick, Noachian clay-rich unit. Mapping and evaluating the geometry of the layers throughout the region helps to constrain the depositional processes, and hence to understand the environment at the time of the formation of the unit.

1. Introduction

The Mawrth Vallis region has been shown to display the largest clay-rich outcrops on the surface of Mars with data from OMEGA/Mars Express and CRISM/Mars Reconnaissance Orbiter (MRO). These outcrops correspond to the eroded parts of a thick and expansive thinly-layered unit ([1], [2], [3]), emplaced during the Noachian. Hence, the unit records a past environment where water was available for abundant alteration in the context of a sedimentary unit.
The next rovers to Mars are designed to determine a planet's past or present habitability and discover potential past life. In the context of these missions, Mawrth Vallis is an attractive potential landing site, and has been selected as one of the fourth final candidate landing site for the Mars Science Laboratory (MSL). A remaining unknown about the clay-unit is the origin of the layered unit:fluvio-lacustrine, aeolian, volcaniclastic or impact processes have all been suggested ([2], [3]).
Studying the stratigraphy of this clay-unit with orbital data may contribute to interpreting the deposition of the layers.

2. Datasets

Layers in the Mawrth Vallis region were first observed with MOC/Mars Global Surveyor, but could hardly be distinguished from each other. The bright layered rocks were possibly interpreted as lacustrine or shallow-marine in origin [4].

Newer HiRISE/MRO images allow distinguishing layers from each other and mapping them over hundreds of meters laterally.

Furthermore, HRSC/Mars Express and HiRISE stereo images provide topographic information that helps to evaluate the geometry of the unit by estimating the dip of layers. However, high resolution HiRISE stereoimages are not acquired systematically and Digital Elevation Model (DEM) have been computed for only few outcrops.

3. Types of layered outcrops

Most of the layered-unit is exhumed at the relatively flat top of the plateau around the valley of Mawrth Vallis, where only few layers are exposed.

Eroded crater walls comprise convenient outcrops to study layering (fig. 1), although fracturing subsequent to the impact can affect the morphology of the crater walls. Crater wall outcrops only give local information on stratigraphy, and of course depends on the presence or absence of a crater. Layered cliffs are also present throughout the region, for example around remnant buttes.

A particular site in the region shows well defined layeres over kilometer long outcrops, and may reveal the general depositional process of the region: the flanks and floor of Mawrth Vallis (fig. 1).

Oyama crater also shows also many layers exhumed along a cliff, but likely represents later clay deposits that post date the main plateau layered unit.

4. Clay-unit geometry

HiRISE images and co-registered HiRISE DEMs at 1 m/pixel enable to estimate the dip of the layers on the top of the plateau, especially at the location of the landing ellipse proposed for the MSL mission. At this place, the layers seem sub-horizontal, with dips lower than 3°, mostly around 1°, preferentially oriented

towards the flank of Mawrth Vallis. However dips estimations show variations at the 100 m-scale.

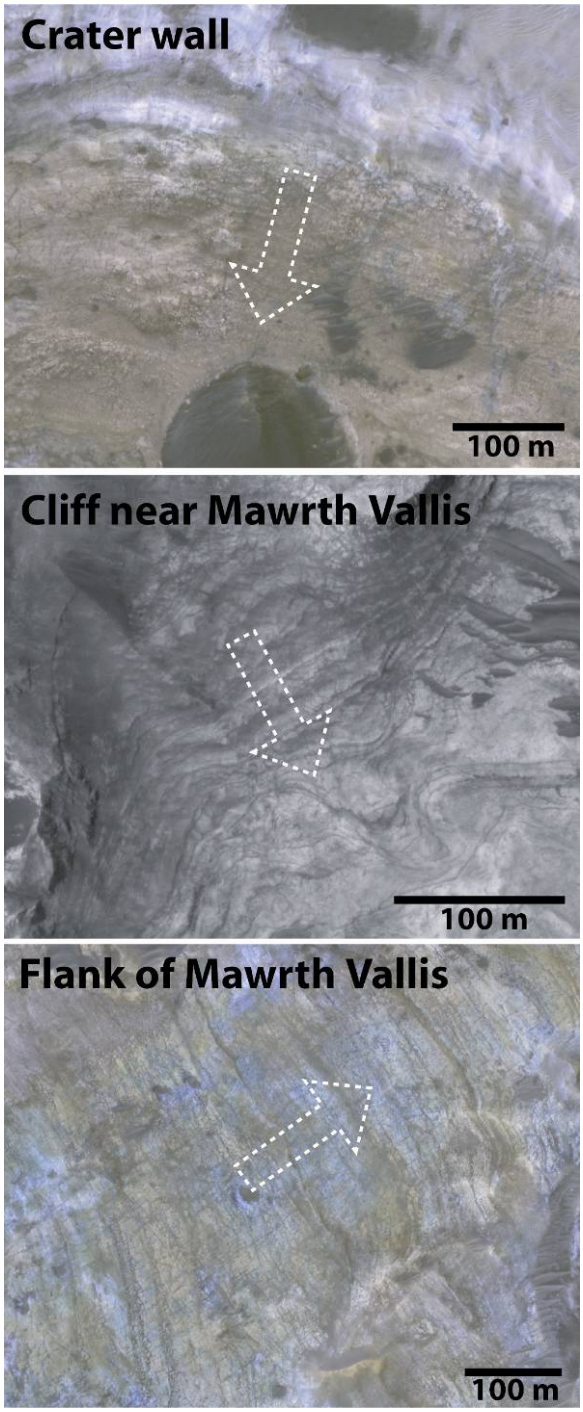

Figure 1: Three examples of layered outcrops with HiRISE images. The open arrows indicate direction of slope.

On the other outcrops throughout the top of the plateaus of the region, exhumed terrains and crater walls also show sub-horizontal layers.

However, HiRISE images near and on the floor of Mawrth Vallis show steep apparent dips. We will continue to evaluate the dips of these layers with all available HiRISE images, using stereo-images on the floor of Mawrth Vallis, and around the streamlined islands, to further evaluate their emplacement.

5. Conclusion

Careful mapping of layers at Mawrth and evaluation of dips could constrain the possible processes and chronology for deposition of the layers of the clay-unit at Mawrth Vallis. In particular, layers in the floor and streamlined islands of Mawrth Vallis are key in the understanding of the geometry of the unit.

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