EPSC Abstracts
Vol. 6, EPSC-DPS2011-1704-1, 2011
EPSC-DPS Joint Meeting 2011

Sedimentary Features in Phyllosilicate-bearing Outcrops of Crater Rims at Mawrth Vallis, Mars

J. L. Bishop (1), J. J. Wray (2,3), M. Parente (4), D. Loizeau (5), R. A. Beyer (1), D. Lowe (6), L. Saper (4), N. K. McKeown (7); (1) SETI Institute, Mountain View, CA, USA, (2) Department of Astronomy, Cornell University, Ithaca, New York, USA, (3) Georgia Tech, Atlanta, GA, USA, (4) Brown University, Providence, RI, USA, (5) ESA-ESTEC, Noordwijk, The Netherlands, (6) Stanford University, Stanford, CA, USA, (7) MacEwan University, Edmonton, AB, Canada; (Email: jbishop@seti.org)

Abstract

The Mawrth Vallis region contains one of the largest phyllosilicate outcrops on Mars with abundant exposures of many aqueous minerals and phases [e.g. 1-6]. The objective of this study is to characterize the mineralogy and morphology of phyllosilicate-bearing rocks at Mawrth Vallis that exhibit possible sedimentary features. If the Mawrth Vallis region is shown to have a sedimentary origin, then that increases the probability that life could have been present here and preserved. Here we present analyses of CRISM and HiRISE images of possible sedimentary deposits in Oyama crater and in the walls of a smaller crater just outside Oyama.

1. Introduction

Extensive phyllosilicate outcrops have been identified at Mawrth Vallis in OMEGA and CRISM images using spectral absorptions at 1.38-1.42, 1.91-1.93, 2.16-2.33 and 2.39-2.41 μm [2,3,4]. The Mawrth Vallis region contains large exposures of Fe/Mg-smectite as the deepest phyllosilicate unit within the ancient cratered terrain. This exists as a thick, pervasive unit that was subsequently covered by material rich in Al-phyllosilicates and hydrated silica.

Many hypotheses have been proposed for the formation of the phyllosilicate-rich units at Mawrth Vallis including emplacement of impact ejecta, volcanic ash, and/or sedimentation via aeolian, fluvial or lacustrine processes. Each process has distinct implications for the paleo-environment and its potential for habitability and biomarker preservation. We are combining analyses of the mineralogy with analyses of the stratigraphy and morphology of the layers in order to assess the possibility of a sedimentary origin of the phyllosilicates.

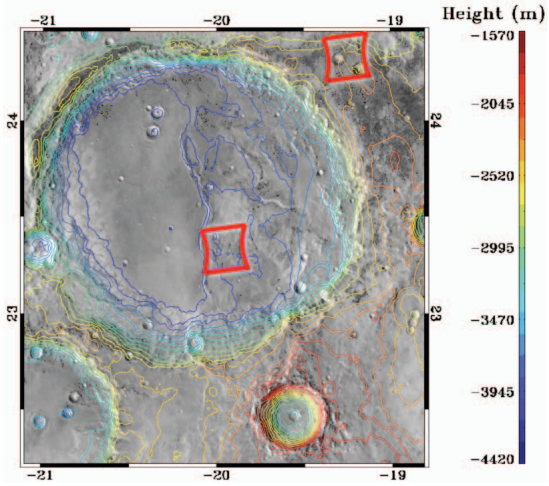

Figure 1: Map of Oyama crater. CRISM image locations marked by red boxes; HiRISE image sites within CRISM borders; elevations from MOLA; image ~100 km wide.

2. Crater Rim Exposures

Crater rim exposures often exhibit clear spectral signatures of the phyllosilicate units with distinct stratigraphy. Examples are depicted in a CRISM mineralogy map and spectra (Figs. 2-3) and HiRISE images (Figs. 4-5). The phyllosilicate stratigraphy observed here is similar to elsewhere in Mawrth Vallis [e.g. 3,5]; however it is much more accessible along these rim exposures. Selected spectra collected from the crater rim units (Fig. 2) using standard image processing techniques [7] exhibit features due to hydrated silica and/or Al-smectite; a mixture of Fe^{2+} material with the upper and lower phyllosilicate units, and Fe^{3+}/Mg-smectite. Many spectra in these phyllosilicate units also contain a carbonate-like feature near 2.5 μm. Preliminary spectra acquired using endmember analyses indicate that some spectra

in this image are characterized by bands near 2.32 and 2.53 µm [8] consistent with carbonate.

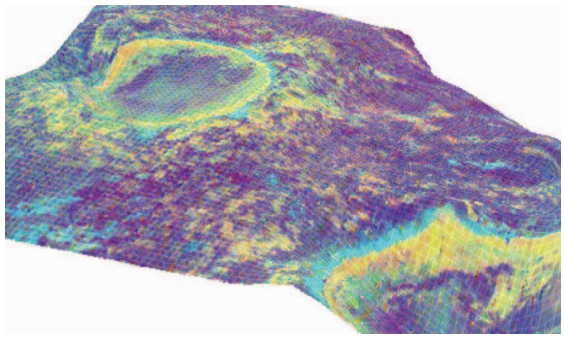

Figure 2: 3D mineral map of CRISM image FRT000094F6 draped over MOLA elevations (R: Fe^{3+}/Mg-smectite, G: Fe^{2+} material, B: Al-phyllosilicate and/or SiOH).

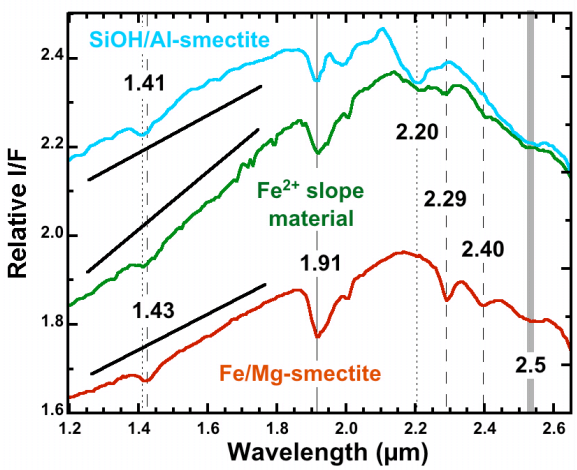

Figure 3: Phyllosilicate spectra from crater rim deposits in CRISM image FRT000094F6.

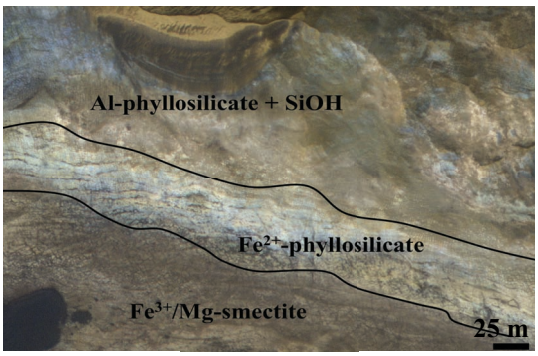

Figure 4: Portion of HiRISE mosaic from images PSP_ 004052_2045 and ESP_012873_2045 illustrating bedding morphologies and discordant layering in Fe/Mg-smectite unit shown in Fig. 2.

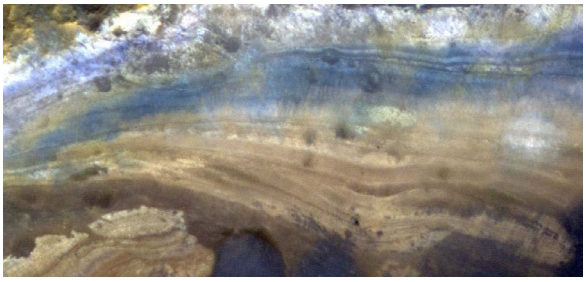

Figure 5: Portion of color HiRISE image ESP_022288_2035 showing discordant layering in Oyama floor deposit cut by small crater.

The HiRISE images illustrate differences in color and texture of each unit as well as layering (Fig. 4-5). The band of Fe^{2+} material is clearly observed dividing the Al-phyllosilicate and hydrated silica unit above and the Fe^{3+}/Mg-smectite unit below. The bedding varies from convergent, to near parallel, to divergent and some exposures exhibit discordant layering and are reminiscent of soft-sediment deformation.

3. Implications

Phyllosilicate units up to 200 km thick are observed throughout the Mawrth Vallis region and many of these exhibit discordant layering that closely resemble scour and truncation surfaces common in terrestrial sedimentary deposits. The two sites described here illustrate examples of discordant layering that are consistent with a changing environment and depositional processes. The smectite, silica and carbonate mineralogy is also consistent with sedimentary processes. If these are sedimentary deposits, then the chances of early life here and preservation of any biosignatures is increased.

Acknowledgements

Funding from NASA's MRO project and the SETI REU program is greatly appreciated.

References

[1] Poulet F. et al. (2005) Nature, 438, 632-627. [2] Loizeau D. et al. (2007) JGR, 112, doi:10.1029/2006JE002877. [3] Bishop J.L. et al. (2008) Science, 321, 830-833. [4] Wray J.J. et al. (2008) GRL, 35, doi:10.1029/2008GL034385. [5] McKeown N.K. et al. (2009) JGR, 114, doi:10.1029/2008JE003301. [6] Noe Dobrea E.Z. et al. (2010) JGR, 115, doi:10.1029/2009JE003351. [7] Murchie S.L. et al. (2009) JGR, 114, doi:10.1029/2009JE003344. [9] Parente M. (2011) CRISM Team Meeting.