Extent and Nature of Clay-Rich Deposits : from Oxia Planum to Mawrth Vallis

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Abstract

The study of clay-rich deposits is key to understanding past water activity on Mars and its **early habitability potential**. Strong phyllosilicate signatures have been identified over the **Mawrth Vallis** plateau based on the **OMEGA** instrument [1]. Similarly, large clay-rich deposits have been detected in **Oxia Planum** [2], the landing site of the **ExoMars** Rosalind Franklin rover mission. The rover aims to investigate the Martian surface and subsurface with its two-meter-deep drill, searching for potential traces of **life preserved** in these clay-bearing units [3].

The **proximity of both sites** and their similar position **straddling the crustal dichotomy** calls for the investigation of the relationship between these two major clay-rich units. This poster presents our latest findings on their **extent**, **nature** and current **stratigraphic relationship** investigations.

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Cassini crater, ESA / MEX / HRSC

01 INTRODUCTION

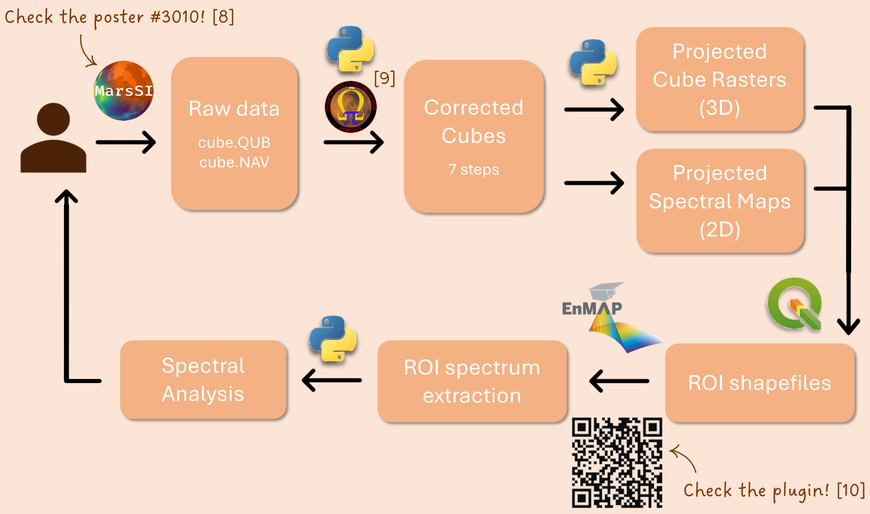
Clay-deposits from Oxia Planum and Mawrth Vallis have been characterized using **OMEGA** & **CRISM** hyperspectral data [4 to 7]:

- **Oxia Planum**-clay type: best fitted with **vermiculite** and **saponite** (Fe/Mg-rich phyllosilicates).
- **Mawrth Vallis**-clay type: consistent with **montmorillonite** (Al-rich) and **nontronite** (Fe^{3+}/Al-rich) smectites.

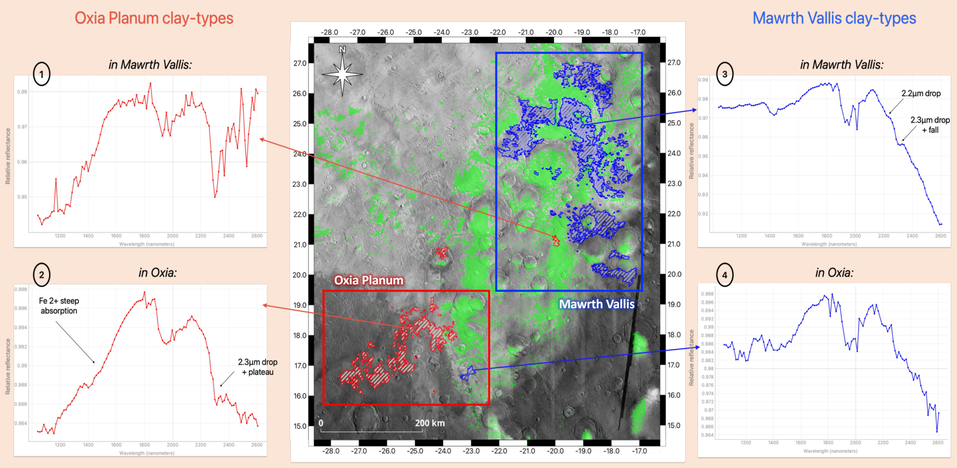
See Map 1 Spectra

Method: (1) We processed OMEGA spectral cubes due to their extensive spatial coverage. (2) We created spectral maps to monitor variations inside the clay units. (3) Finally, we combined spectral data with optical images in order to link specific morphologies with a corresponding clay-type.

02 DATA PROCESSING

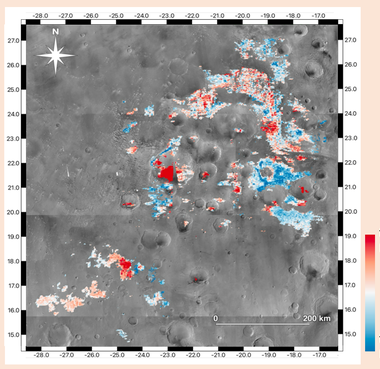


03 SPECTRAL MAPS

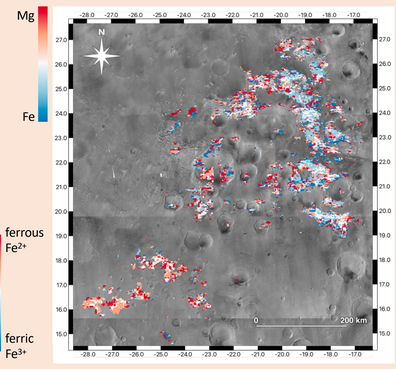


Map 1: OP-type (red) versus MV-type (blue) of clays [11], and pyroxenes [12] (green). Basemaps: OMEGA dust emissions [13] in transparency over THEMIS-day.

- We distinguish **two clay types:** Oxia Planum (**OP-type**) and Mawrth-Vallis (**MV-type**), in both regions.
- We observe **variations inside the clay units:** 1–1.7µm slope (Fe^{2+} or Fe^{3+}) & 2.3µm absorption feature shape (Fe or Mg), coherent with OP-type vs MV-type spectral observations.
  → different geochemical environments



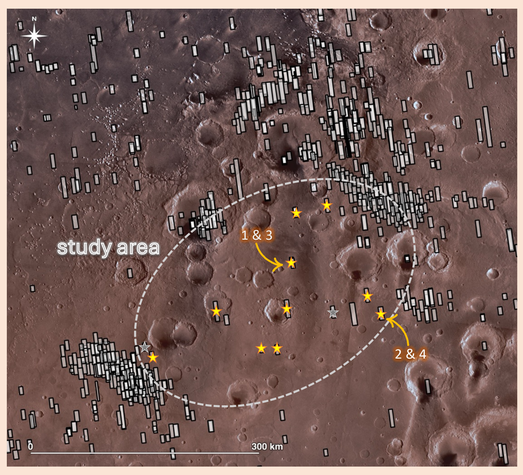
Map 2: ferric vs ferrous criterion map.



Map 3: position of the 2.3µm drop

04 OPTICAL IMAGING

Morphologies	OP-type	MV-type
Bright & fractured bedrock	1	2
Layering in crater walls Blueish / Reddish layer tones	3	
Remnant buttes	4	



Map 4: HiRISE RED footprints over Viking mosaic.
☆ = fractured, light, bedrock exposures
★ = no exposures

- Almost each HiRISE MIRB between Oxia Planum and Mawrth Vallis exhibit **morphologic features** characteristic of clays [14].
- Elements of **stratigraphy** between the two units have also been spotted, such as crater wall layerings, or remnant buttes. Suggesting that **MV-type clays are lying on top of the OP-type ones**.

05 CONCLUSION & REFERENCES

There seems to be a **clay continuity between Oxia Planum and Mawrth Vallis**. Spectral analysis over clay clusters was possible after making adaptations to the EnMAP-Box Plugin [10]. It allowed us to identify **two main clay families**: the "Oxia Planum" **OP-type**, and the "Mawrth Vallis" **MV-type**. Our spectral maps show **variations** inside these clay families (section 03), indicating they may have formed in **different geochemical environments**. The few spectral clay signatures we observe between the two regions could be explained by lava flows or dust covering them. We are currently using optical images to define the stratigraphic relationship between OV- & MV-type clays: our preliminary findings suggest that **the MV-type unit lies on top of the OP-type**. In the future, we want to extend this work to the larger contour of Chryse Planitia → for future updates, check out the paper Torres et al. 2024, in preparation.

[1] Poulet F. et al. (2005) Nature, 438(7068), 623-627. [2] Carter J. et al. (2016) 47th LPSC, Abstract #2064. [3] Vago J. L. et al. (2017) Astrobiology, 17(6-7), 471-510. [4] Quantin-Nataf C. (2021) Astrobiology, 21(3), 345-366. [5] Bishop J. (2008) Science, 321(5890), 830-833. [6] Loizeau D. (2007) JGR: Planets, 112(E8). [7] Bibring J.-P. et al. (2004) ESA Spec. Pub., SP-1240. [8] Volat M. et al. (2024) Tenth International Conference on Mars, Abstract #3010 [9] Stcherbinine A. (2023) Zenodo. [10] Jakimow B. et al. (2023) SoftwareX, 23, 101507. [11] Carter J. et al. (2013) PSS, 76, 53-67. [12] Ody A. et al. (2012) JGR: Planets, 117(E11). [13] Audouard J. et al. (2014) Icarus, 233, 194-213. [14] Fawdon P. et al. (2024), Journal of Maps, 20(1).