THE DISTRIBUTION OF PHYLLOSILICATES IN MAWRTH VALLIS AS SEEN BY CRISM.
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Introduction: Mawrth Vallis has one of the largest exposures of phyllosilicates on Mars. Originally observed by OMEGA [1-4], CRISM has refined the detections [5] and allowed positive identification of several phyllosilicate minerals including nontronite, montmorillonite, and kaolinite, as well as hydrated silica, based on their distinct spectral characteristics [6]. The identification and mapping of phyllosilicates is critical to understanding the geologic history of Mars as they only form in the presence of liquid water. Additionally, these species form via different processes, allowing us to further refine the geologic history of the region in the mid-to-late Noachian.

Data and Methods: Targeted MRO/CRISM images (FRT's) collect 544 wavelengths from 0.36 to 3.9 µm in ~10-12 km wide swaths at ~18m/pixel [7]. Half-resolution images (HRL's and HRS's) have the same spectral properties, but half the spatial resolution at ~40m/pixel. Images are processed for instrumental effects, converted to I/F and the atmosphere is removed using a ratio with a CRISM scene of Olympus Mons, scaled to the same column density of CO_2 [5]. Ratios to spectrally unremarkable regions in the scene are used to help resolve spectral features. Spectra were extracted from 5X5 or 10X10 pixel regions when possible.

CRISM image footprints were combined with MOLA elevation data using ArcGIS. Mineral data from CRISM image analyses were added to the database and maps created based on this mineral data. This study has focused on the central region of Mawrth Vallis. See related abstract for information on the extent of phyllosilicates in Mawrth Vallis [8].

Discussion: Specific phyllosilicates and hydrated material can be identified by characteristic spectral features [e.g. 9-12]. CRISM spectra of material consistent with these classes are shown in Fig. 1:

- Fe/Mg-smectites have absorptions at 2.41um, ~2.30um, 1.91um, and 1.42um
- Al-phyllosilicates have absorptions at 2.21 um, 1.91 um, and 1.41um
- Mica has absorptions in the range 2.2 to 2.35um, weak ~1.4 and 1.93um hydration bands, and in these observations, often a ferrous slope from 1.0-1.9um
- Hydrated silica has a broad 2.2um absorption and a weak 1.93um absorption [10, 11].

Nontronite, the most commonly identified Fe/Mg-rich phyllosilicate in Mawrth (see related abstracts [8, 12]), forms as the weathering product of basalt and from Fe- and Si-rich hydrothermal deposits. Montmorillonite, identified in several images [6,12,13], is an Al-rich phyllosilicate with interlayer water that typically forms from weathered volcanic ash. Illite (mica) is Al-rich, but lacks interlayer water and forms by weathering or hydrothermal alteration of muscovite or smectites or alteration of K-spar. Opal (hydrated silica) forms by alteration of basalt, high-silica extrusives, or volcanic tuffs [e.g. 10, 14-19]. Frequently, the weak 1.9 µm band plus broad feature near 2.2-2.3 µm indicative of mica or hydrated silica is associated with an Fe^{2+} slope, suggesting the presence of ferrous mica.

Regional mapping (Fig. 2) shows widespread distribution of Fe/Mg-phyllosilicates in all images with phyllosilicate outcrops. Outcrops of Al-phyllosilicates are observed only in regions with higher elevations, as is mica. Hydrated silica is observed in images with intermediate elevations. No other obvious spatial relationship has been observed, suggesting regional rather than local alteration/depositional processes. A potential scenario might be 1) Alteration of basalt or basaltic ash to form nontronite; 2a) subsequent alteration and leaching of the upper layers to form montmorillonite, mica, and hydrated silica; or 2b) simultaneous or subsequent alteration of overlying pyroclastic deposits to form montmorillonite, mica, and hydrated silica (see related abstract [12] for other scenarios). All scenarios require extensive liquid water in an underground aquifer, a large surface lake/sea, or as precipitation in the mid-to-late Noachian.

References: [1] Poulet, F., et al. (2005) *Nature*, 438, 632-627. [2] Noe Dobrea, E.Z. and Michalski J.R. (2006) *AGU Fall 2006*, #P23D-0091. [3] Michalski, J.R. and Noe Dobrea, E.Z., (2007) *Geology*, 35, 951-954 [4] Loizeau D. et al. (2007) *JGR*, 112 (E8). [5] Mustard, J.F., et al. (2007) *Nature*, submitted. [6] Bishop, J. L. et al. (2007) *AGU Fall 2007*, #P13D-1559. [7] Murchie, S. L. et al. (2007) *Nature,* submitted. [8] Noe Dobrea, E. Z. et al. (2008) *LPSC XXXIX*, abstract #1077. [9] Bishop J.L. et al. (2002) *Clay Minerals*, 37, 617-628. [10] Bishop J.L. et al. (2007) *Clays and Clay Minerals*, 55, 1-17. [11] Bishop, J. L. et al. (2008) Clay Minerals, in press. [12] Bishop, J. L. et al. (2008) *LPSC XXXIX.* [13] McKeown, N. K. et al. (2007) *AGU Fall 2007*, #P13D-1558. [14] Milliken R. E. et al. (2008) *LPSC XXXIX.* [15] Jackson, M. L.

(1959) *Clay and Clay Minerals*, 6, 133-143. [16] Velde, B. (1985) *Clay Minerals* Elsevier. [17] Chamley, H. (1989) *Clay* Sedimentology Springer-Verlag. [18] Deer, W. A. et al. (1992) *An Introduction to the Rock-Forming Minerals*, Longman. [19] Nagy, K. L. (1995) *Chemical Weathering Rates of Silicate Minerals*, 173-233, Min. Soc. America.

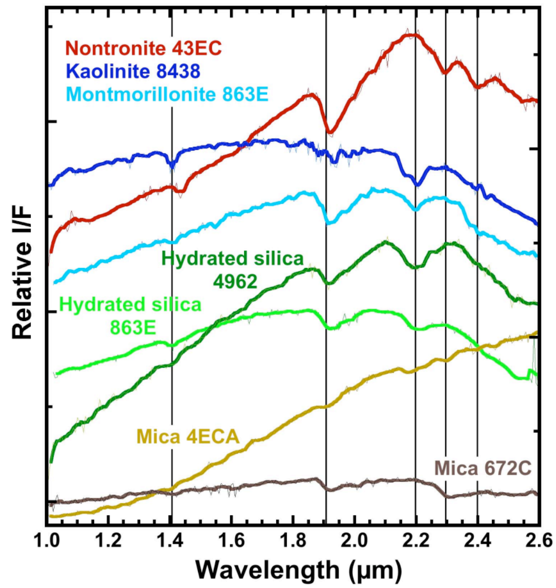

Fig. 1. (Right) Select examples of mineral type spectra from Mawrth Vallis. The number after each mineral name is the CRISM image the spectrum was retrieved from. All spectra are ratio spectra, derived as described in the text. Montmorillonite and kaolinite are combined under the Al-phyllosilicate category in Fig. 2. They can be discriminated in CRISM spectra by the kaolinite shoulder near 2.16 µm and a weak or absent band near 1.9 µm.

Fig. 2. (Below) Maps of CRISM image footprints overlain on MOLA elevation data, ~415km across, white is higher elevation. a) Fe/Mg-phyllosilicates; yellow=present in that image, blue=absent. b) Al-phyllosilicates. c) Mica. d) Hydrated silica. There are several footprints with no detections; these are images of the overlying cratered plain unit that contain no phyllosilicates.