

EVIDENCE OF THE PRESENCE OF JAROSITE AND DIAGENETIC ACTIVITY IN THE MAWRTH VALLIS REGION. W.H. Farrand¹ J.W. Rice, Jr.², T.D. Glotch³. ¹Space Science Institute, 4750 Walnut St. #205, Boulder, CO 80301, farrand@spacescience.org, ²Arizona State University, Tempe, AZ, ³Stony Brook University, Stony Brook, NY.

Introduction: The Mawrth Vallis region has been identified by the Mars Express OMEGA and MRO CRISM instruments as a region with abundant hydrated phyllosilicate minerals [1,2,3]. Exposures of light-toned, phyllosilicate-bearing layered rocks are areally extensive at Mawrth Vallis. The Mawrth Vallis region hosts a diverse assemblage of phyllosilicate minerals. Reflectance spectra of these minerals can be used to determine a “spectral stratigraphy” for the region. A simplified spectral stratigraphy consists of a basal sequence of nontronites and/or Fe, Mg smectites with a distinctive 2.29 μm absorption band overlain by a set of minerals displaying an absorption at 2.2 μm . In [4] it was suggested that the layers displaying the 2.2 μm absorption feature were draped over the Mawrth Vallis outflow channel topography; thus there is potentially a large unconformity between the beds displaying the 2.29 μm band and those displaying the 2.2 μm absorption feature. Here we address in more detail the transition from the 2.29 μm band-bearing layers to those evincing a 2.2 μm band and examine materials exposed in association with that transition zone.

Data: Numerous CRISM HRL and FRT scenes have been collected over the Mawrth Vallis region, largely in order to examine its viability as a possible Mars Science Laboratory landing site. CRISM data were converted to apparent surface reflectance using a “volcano scan” approach [5]. We have also utilized alternately an implementation of a denoising approach described by [6] and/or a flat-field correction utilizing a line-by-line average. Currently, we are also working on utilizing a look-up table correction based on DISORT radiative transfer modeling [7].

Transition Zone Materials: Here we refer to the stratigraphic region consisting of the surface/upper portion of the 2.29 μm band-displaying layers and the lower portions of those strata that display a 2.2 μm band and any other materials between as being the “Transition Zone”. In [3] a set of surfaces that display a sloping, concave upwards spectrum (example in **Fig. 1**) between approximately 1.0 to 2.0 μm were described as being transitional between the 2.29 and 2.2 μm band bearing materials. In [3] it was suggested that the surfaces displaying this spectral signature could be ferrous iron bearing micas. A problem with this interpretation is that spectra of this nominal Fe^{2+} - bearing mica (hence forwards described as “Fe2M”

materials) do not display a doublet absorption at 2.30 and 2.35 μm as in celadonite or at 2.31 and 2.37 μm as in glauconite. While an exact mineralogic assignment for this spectral signature remains in doubt, we note that it is persistent across the Mawrth Vallis region. We have also noted that surfaces that display this spectral signature are, in some instances, more resistant to erosion than the underlying nontronite / Fe, Mg smectite. We have also identified at least one location (in the FRT A600 scene) where a fracture transitions into a flat-topped ridge that displays this Fe2M spectral signature.

We have observed that in CRISM “S” spectrometer visible to near infrared data, that there are regions with higher 530 nm band depth [8] values and that these regions occur only over terrains that display the 2.29 μm band or the Fe2M spectral signature- not over the terrains that display the 2.2 μm band (**Fig. 2**).

We have also identified a location in a single CRISM FRT scene (FRT A425; **Fig. 3**) where there is an ovoid shaped region, that is stratigraphically between nontronitic / Fe, Mg smectite materials and materials displaying a 2.2 μm band. This region displays an asymmetric absorption band with a 2.265 μm minimum and also bands apparent at 2.51 μm and 1.9 μm . The 2.265 μm band and 2.5 μm band correspond to similar features in jarosite, with K jarosite being the best match. Jarosite also displays a weak 1.47 μm band and a stronger band at 1.85 μm . These bands are not apparent in this region; however, we suggest that the jarosite might be occurring in combination with a water-bearing phase that is contributing to the observed 1.9 μm band. In [9] it was suggested, based on TES spectral analyses that zeolites are present at Mawrth Vallis so zeolites could be present with the jarosite and be the cause of the 1.9 μm band. The putative jarosite spectrum is compared to a jarosite laboratory spectrum in **Fig. 4**.

Discussion: In [10] it was suggested that a majority of the phyllosilicate-bearing layers on Mars were deposited early in Mars’ history when groundwaters were predominantly alkaline and that Mars underwent a climatic/environmental shift to more acidic conditions during which time sulfate-bearing layers were deposited. We suggest that there is a profound unconformity between the cessation of deposition of materials that either then had, or were later altered to contain, the nontronite and Fe, Mg smectite minerals and

the later materials that display a 2.2 μm absorption band. One supporting piece of evidence is that surfaces with higher 530 nm band depths occur on the nontronite/Fe, Mg smectite surfaces or Fe2M surfaces, but not on surfaces with a 2.2 μm band. We interpret this as evidence that the former surfaces were exposed (however, not uniformly exposed since there is not a complete correspondence between high 530 nm band depth surfaces and nontronite or Fe2M surfaces) for some period of time and that the high 530 nm band depth might be caused by some coating formed on the exposed surfaces. Also, we suggest that the mineral or minerals responsible for the Fe2M spectral signature were introduced during a period of diagenesis. Evidence for this assertion includes the association of this spectral signature with at least one occurrence of a fracture with a discolored border.

The occurrence of the jarosite-bearing materials, since it does appear to be spatially restricted might be the result of some local event such as deposition of S-bearing ash from an eruption into a transient lake or it could represent the transition to more acidic conditions. We note that the upper layers that display the 2.2 μm band might also have been produced in a period with lower pH groundwaters since kaolinite, montmorillonite, and opaline silica (minerals observed in these upper layers [3]) can all be associated with acid sulfate systems.

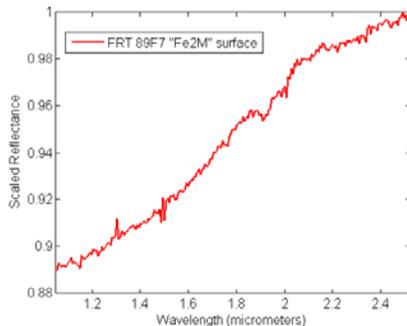


Fig. 1. Spectrum of the “Fe2M” material from the FRT 89F7 scene, ascribed by [3] to be a ferrous mica.

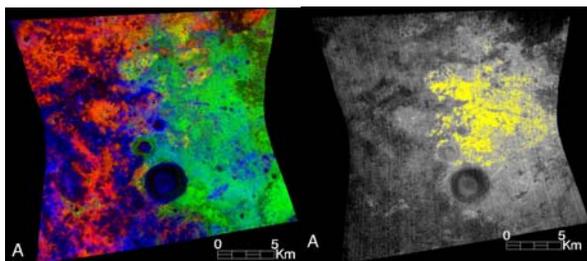


Fig. 2. **A.** SMA fraction image composite of FRT 89F7 (R = 2.2 μm materials, G = 2.3 μm materials, B = “Fe2M” materials). **B.** 530 nm band depth image with values > 0.12 thresholded and shown as yellow- note

association of high 530 nm band depth values with some of the nontronite-bearing terrains.

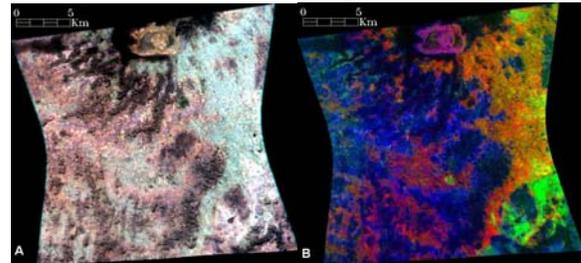


Fig. 3. **A.** RGB composite of FRT A425 SWIR data (R=2.5, G=1.5, B=1.08 μm). **B.** Composite of SMA fraction images (R=2.2 μm band bearing material, G=nontronite-bearing surfaces, B=Fe2M like surfaces. Jarosite-bearing area appears in magenta.

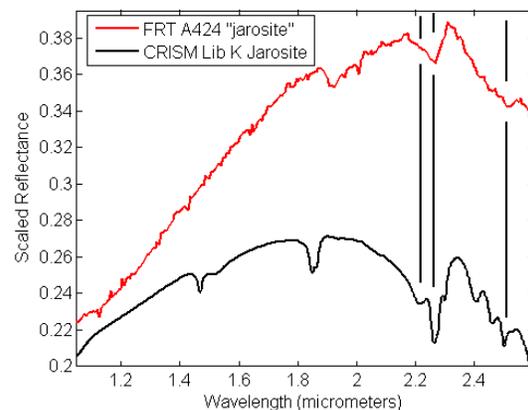


Fig. 4. Average spectrum from putative jarosite region in FRT A425 in red compared with CRISM library jarosite in black.

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] Wray et al. (2008) *GRL*, **35**, L12202, doi:10.1029/2008GL034385. [5] Langevin, Y. et al. (2005) *Science*, **307**, 1584-1586. [6] Parente, M. (2008) *LPS XXXIX*, #2528. [7] McGuire, P. et al. (2008) *IEEE TGARS*, **46**, 4020-4040. [8] Pelkey, S. et al. *JGR*, **112**, doi:10.1029/2006JE002831. [9] Michalski, J. and R. Fergason (2009) *Icarus*, **199**, 25-48. [10] Bibring, J.P. (2006) *Science*, **312**, 400-404. [11]

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