FERRIC AND POSSIBLE FERROUS SULFATES IN THE NORTHERN MAWRTH VALLIS REGION OF MARS.

W.H. Farrand[1], T.D. Glotch[2] and B. Horgan[3], [1]Space Science Institute, 4750 Walnut St., #205, Boulder, CO 80301, farrand@spacescience.org, [2]Stony Brook University, Stony Brook, NY, [3]Purdue University, W. Lafayette, IN.

Introduction: The Mawrth Vallis region has been intensively studied largely on the basis of its extensive exposures of phyllosilicate-bearing outcrops [e.g., 1-4]. However, sulfates have also been observed in the form of isolated exposures of the ferric sulfate jarosite near the top of its stratigraphic section [5,6] and scattered exposures of a phase described as an acid-leaching product [7]. The CRISM "SINDX" parameter [8], which is a measure of the convexity of spectra at 2.29 μm, can result from water and/or sulfate molecule absorptions in the 1.9 to 2.1 μm region and/or at 2.4 μm. There are scattered areas with high values of the SINDX parameter in a number of CRISM scenes. Here we examine several CRISM full-resolution targeted (FRT) and half-resolution long (HRL) scenes from the northern portion of the Mawrth Vallis region (**Fig. 1**) in order to determine what mineralogic phase or phases might be responsible for these high SINDX values.

Processing of CRISM Data: Atmospheric correction of CRISM near IR "L" spectrometer scenes was performed using the "volcano scan" approach resident in the CRISM Analysis Tools (CAT) software package. Mitigation of atmospheric dust effects in the visible to near IR "S" spectrometer data was achieved by subtracting an average of several pixels in shadow in each scene and dividing through by a spectrally flat average spectrum.

Given that a number of sulfate minerals have absorption featues in the 2.3 to 2.6 μm region, special attention was paid to this spectral region using a set of spectral matching metrics including a spectral feature fitting approach [9], a spectral similarity value [10], and a Pearsonian correlation coefficient [11]. Region of interest (ROI) average spectra over high SINDX areas were also examined using a non-linear unmixing methodology based on Shkuratov scattering theory [12].

Results from CRISM "L" Spectrometer: Average ROI spectra from FRT0000AA7D and from FRT0000863E are shown in **Fig. 2A** with continuum-removed versions of these spectra in the 2.3 – 2.6 μm range shown in **Fig. 2B**. The latter spectra highlight the presence of absorptions near 2.4 and 2.52 μm. Comparisons of these and other spectra were made to a spectral library convolved to this spectral range and to CRISM resolution that included sulfates, phyllosilicates, and zeolites. The best matches through both the spectral matching approaches and through the non-linear unmixing were to a group of ferrous or mixed ferrous/ferric sulfates including rozenite, melanterite, copiapite and ferricopiapite. Continuum-removed library spectra of these minerals over the same spectral range as in **Fig. 2B** are shown in **Fig. 3**.

Results from CRISM "S" Spectrometer:. **Fig. 4** shows spectra from the CRISM "S" spectrometer over areas corresponding to the "L" spectrometer high SINDX regions. These spectra have band minima near 0.87 μm and, for some of these regions, sharp 0.43 μm absorptions. These features are more consistent with a copiapite or ferricopiapite than with rozenite or melanterite (**Fig. 5**).

Discussion: The presence of a mixed ferrous/ferric sulfate such as copiapite or ferricopiapite or possibly ferrous sulfates such as rozenite or melanterite in this region are further evidence of the action of acidic waters in the Mawrth Vallis region. In [13], we discuss the broader implications of the action of acidic groundwaters, potentially as a fluctuating groundwater table, producing conditions similar to those observed in association with terrestrial acid sulfate soils [e.g., 14]. The acidic waters could also have played a role in the formation of the upper Al phyllosilicate unit in Mawrth Vallis.

References: [1] Bibring J.-P. et al. (2005) *Science*, **312**, 400–404. [2] Michalski J.R. and E.Z. Noe Dobrea (2007) *Geology*, **35**, 951–954. [3] Bishop J.L. et al. (2008) *Science*, **321**, 830–833. [4] Loizeau D. N. et al. (2010) *Icarus*, **205**, 396-418. [5] Farrand, W.H. et al. (2009) *Icarus*, **204**, 478-488. [6] Michalski, J.R. et al. (2013) *Icarus*, **226**, 816-840. [7] Noe Dobrea, E.Z., et al. (2011) *Mars*, **6**, 32-46. [8] Pelkey, S.M. et al. (2007) *JGR*, **112**, 10.1029/2006JE002831. [9] Clark, R.N. et al. (1990) *2nd AVIRIS Workshop, JPL Pub. 90-54*, 176-186. [10] Granahan, J. (2002) *JGR*, **107**, 10.1029/2001JE001759. [11] Abilio de Carvalho, O. et al. (2000) *Proc. 9th JPL Airborne Earth Sci. Wkshp., JPL Pub 00-18*, 65-74. [12] Shkuratov, Y. et al. (1999) *Icarus*, **137**, 235-446. [13] Horgan, B. et al. (2014) This meeting. [14] Van Breeman, N. (1982) *SSSA Special Pub. 10: Acid Sulfate Weathering*, 95-108.

Acknowledgements: Initial work on this research was done under a NASA Mars Data Analysis Program grant.

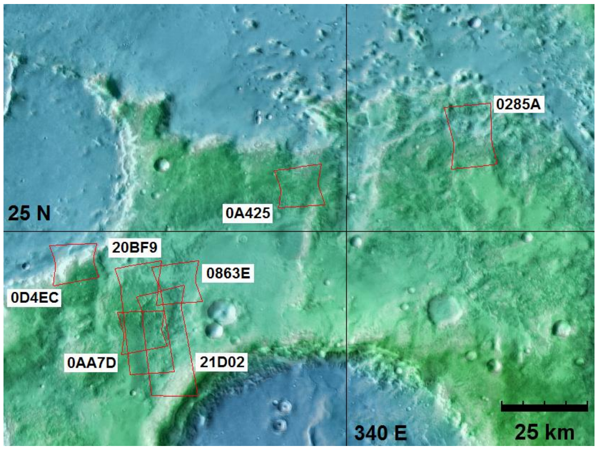

Fig. 1. Northern Mawrth Vallis region considered in this study with outlines of primary CRISM scenes.

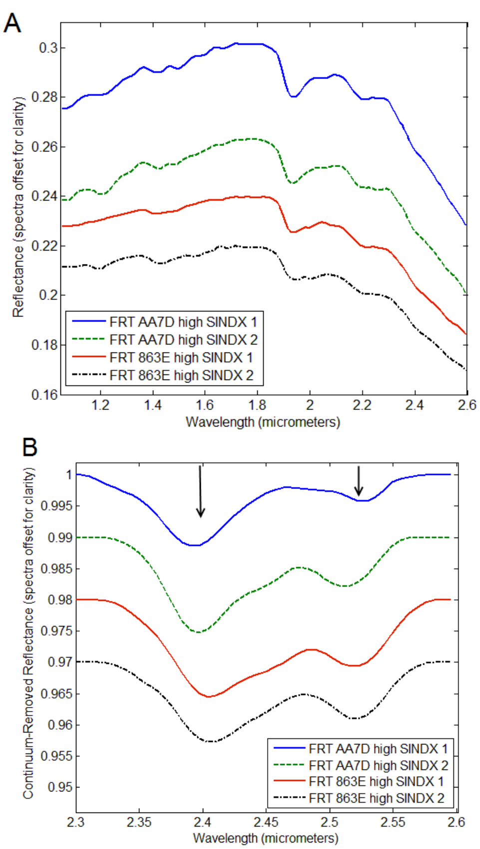

Fig. 2. A. Smoothed ROI average spectra over high SINDX areas from two CRISM scenes. **B**. Continuum-removed portions of those spectra over the 2.3 to 2.6 μm range with absorptions near 2.4 and 2.52 μm noted by arrows.

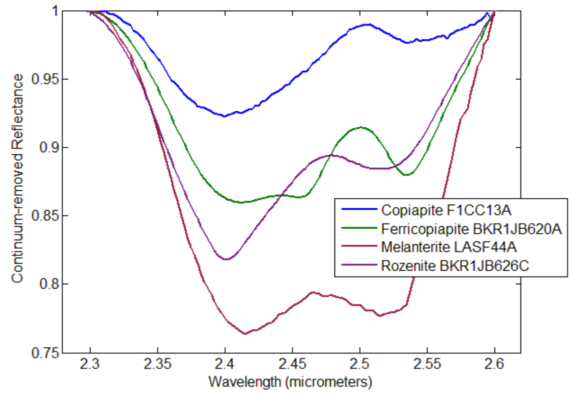

Fig. 3. Continuum-removed CRISM library spectra of best spectral matches in the 2.3 to 2.6 μm region.

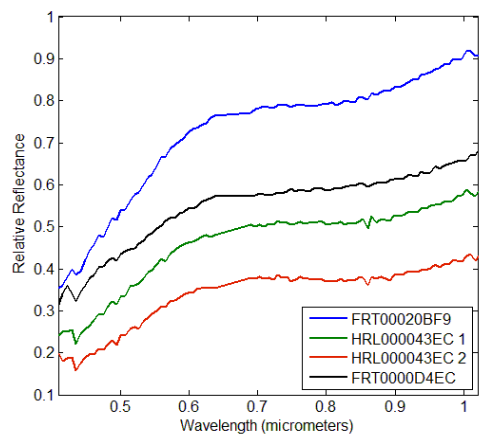

Fig. 4. CRISM "S" spectrometer spectra over high SINDX regions.

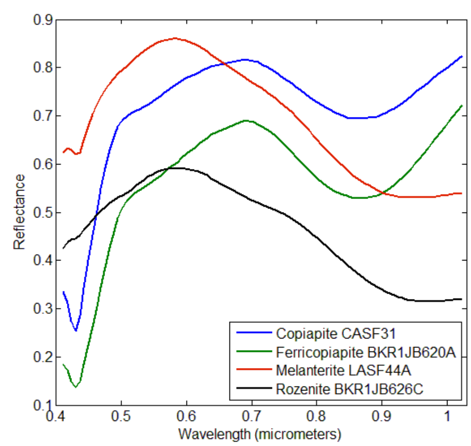

Fig. 5. Library spectra of candidate Fe sulfate minerals over VNIR range of CRISM "S" spectrometer.