REGIONAL PREVALENCE OF FE-SULFATES ON MARS Suniti Karunatillake,[1,2] James J. Wray,[3] Olivier Gasnault,[4] Scott M. McLennan,[2] A. Deanne Rogers,[2] Steven W. Squyres,[5] and William V. Boynton[6], [1]Louisiana State University, LA 70803 (wk43@cornell.edu); [2]Stony Brook University, NY 11794; [3]Georgia Institute of Technology, GA 30332; [4]Université de Toulouse [UPS], F-31000 Toulouse, France; [5]Cornell University, NY 14853; [6]University of Arizona, AZ 85721.

Introduction: The distribution of H_2O-bearing phases on Mars may control habitability and H_2O activity; the pH and stable temperatures of brines would also be affected. Recent identification of sulfates as minerals important to the presence of chemically bound H_2O both by in situ[1,2] and orbital[3] missions motivates the search for spatial patterns to the stoichiometric H_2O : S molar ratio, which we denote as "hydration state" for brevity. We assess this topic from the Mars Odyssey Gamma Ray Spectrometer (GRS) derived H_2O and S mass fraction distributions in the midlatitudinal subsurface at decimeter depths.

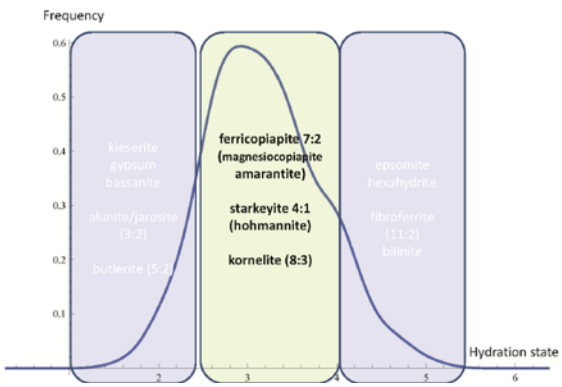

Figure 1 Frequency histogram of hydration states in the mid-latitudes smoothed with a Gaussian kernel.

Methods: Values between the 10th and 90th percentiles of the hydration state distribution (Fig 1, yellow) represent roughly 80% of the Martian midlatitudinal subsurface. This we compare with a comprehensive mineral library of 27 candidate sulfates representing 13 distinct hydration states that may reasonably be expected on Mars according to 21 papers on orbiter data, in situ data,[4] thermodynamic models,[5] climate models,[6] SNC data,[7] and fundamental research.[8] We identify spatial links between w(H_2O) and w(S) with correlation and regression analyses across the hemispheres and hydration states across latitudinal bands.

Results: H_2O and S are weakly correlated, the regression intercept straddles zero, and H_2O content increases with latitude in the Northern hemisphere. Accordingly, the bulk of sulfates may be hydrated heterogeneously in the north.

In contrast, a strong correlation, a positive sulfur intercept at nearly 50% the global average, and hydration states that decrease with latitude characterize the south. Furthermore, H_2O intercepts never exceed 15% of average H_2O mass fraction in either hemisphere and ~68% of H_2O variability is attributable to sulfates in the south.

Discussion: Consequently, we propose that climate and subsurface conditions[9–11] in the Martian midlatitudes have inhibited net hydration of sulfates and sustained heterogeneous hydration states[cf.,12,13] while binding most H_2O to sulfates. Accordingly, the abundance of H_2O affects the degree of sulfate hydration more than the S content.

In our library of candidates, Mg/Ca-sulfates[3,4,14–16] are lacking in the likely hydration states bound between (5:2, 4:1] (Fig. 1 yellow), whereas many stable Fe-sulfates -- such as ferricopiapite, amarantite, hohmannite, and copiapite -- exist. Minerals locally common in the visible and near infrared (VNIR) spectral observations -- kieserite,[3] epsomite,[15] hexahydrite,[4] gypsum,[14,16] etc. -- must occur as mixtures of hydration extrema if they were to dominate the composition.

The substantial depth sampling and regional coverage of GRS data suggest that our inferences would apply to the bulk "soil" component of Mars. For example, deliquescence of hydrous Fe^{3+}-sulfates may facilitate recurring slope lineae observed in the Southern Hemisphere. Corresponding concentrated brines at relatively low pH could support extremophilic biology. We expect the Curiosity rover to constrain these possibilities further with depth sampling and long traverse capabilities at Gale crater. Curiosity's preliminary chemical analysis of "Rocknest" soil raises the possibility of Fe-sulfates.

References: [1] Clark, B.C. *et al. EPSL* (2005) [2] Wang, A. et al. *JGR* (2009) [3] Murchie, S.L. *et al. JGR* (2009) [4] Wang, A. *et al. JGR* (2008) [5] Steiger, M. et al. *Geochim. et Cosmochim. Acta* (2011) [6] Halevy, I. et al. *Science* (2007) [7] Righter, K. et al. *EPSL* (2009) [8] Xu, W. et al., *American Mineralogist* (2009) [9] Halevy, I. et al. *GRL* (2009) [10] Tosca, N.J. et al. *Science* (2008) [11] Hurowitz, J.A. et al. *Nature Geosci.* (2010) [12] Roach, L.H. *et al. JGR* (2009) [13] Rice, M.S. *et al. JGR* (2011) [14] Horgan, B. *et al. JGR* (2009) [15] Feldman, W.C. *et al. GRL* (2004) [16] Wray, J.J. et al. *Geology* (2009)