HYDRATION STATE OF MAGNESIUM SULFATES ON MARS. Alian Wang, John J. Freeman, Bradley L. Jolliff, Department of Earth & Planetary Sciences and McDonnell Center for the Space Sciences, Washington University, St. Louis, MO, 63130 (alianw@levee.wustl.edu)

Introduction: Mg-sulfate has been found on Mars by the Mars Exploration Rovers (MER) [1,2,3] and by OMEGA/Mars Express [4,5,6]. The MER data do not directly measure the hydration state of these Mg-sulfates; however, OMEGA spectra suggest kieserite ($MgSO_4 \cdot H_2O$) and "Polyhydrated sulfates." Knowledge of the hydration state of Mg-sulfates currently at or near the surface of Mars is important to tie these evaporate minerals with the hydrogen detected by the Neutron Spectrometer on the Mars Odyssey orbiter [7]. More importantly, their structural character (e.g., crystallinity) and hydration states could be crucial indicators for short-term and long-term hydrologic evolution on Mars. The specific mineralogy of sulfur is also significant in martian H_2O and S cycles, and may play key roles in the potential for habitability.

Experiments: We have studied the stability field and phase transition pathways of hydrous Mg-sulfates using Raman spectroscopy as the major analytical method, accompanied by mass-loss measurements, XRD, and IR spectroscopy. Eighty six samples of pure Mg-sulfates and mixtures of Mg- and Ca-sulfates were studied over 1000 hours at 10 different relative humidities and two temperatures, with 4 different hydration states as starting phases.

Results: Four major results were obtained from these experiments. Figure 1 shows the Raman spectra from this study [8,9,10], with hydration states ranging from anhydrous through 12 H_2O, and $MgSO_4$ in solution. Fig. 2a shows Raman spectra from mixed hydrous Mg-sulfates, which represent experimental products .

(1) Amorphous Mg-sulfate can be formed readily from epsomite and hexahydrite, but not from starkeyite or kieserite, through fast vacuum dehydration or slow dehydration under dry condition (5.5% RH). An amorphous structure can hold up to 3 H_2O per $MgSO_4$ molecule at 50˚C, and is stable under extremely dry (5.5% RH) conditions.

(2) Starkeyite is stable at extremely dry conditions (5.5% RH) at 21˚C ≤ T ≥ 50˚C. The NIR spectral patterns of starkeyite and amorphous Mg-sulfates match the OMEGA spectrum of "Polyhydrated sulfates".

(3) At T≤ 50° C, kieserite is not formed by either fast or slow dehydration of epsomite, hexahydrite, or starkeyite, but can be formed from slow dehydration of amorphous Mg-sulfates and from a mixture of hexahydrite and Ca-sulfate (Fig.2b).

(4) The dehydration rate of hexahydrite can be greatly reduced (over 10 times) when it is first mixed with Ca-sulfates of all hydration states.

Figure 1. Raman spectra of hydrous & anhydrous, crystalline and amorphous Mg-sulfates as the basis of the current study[8,9,10].

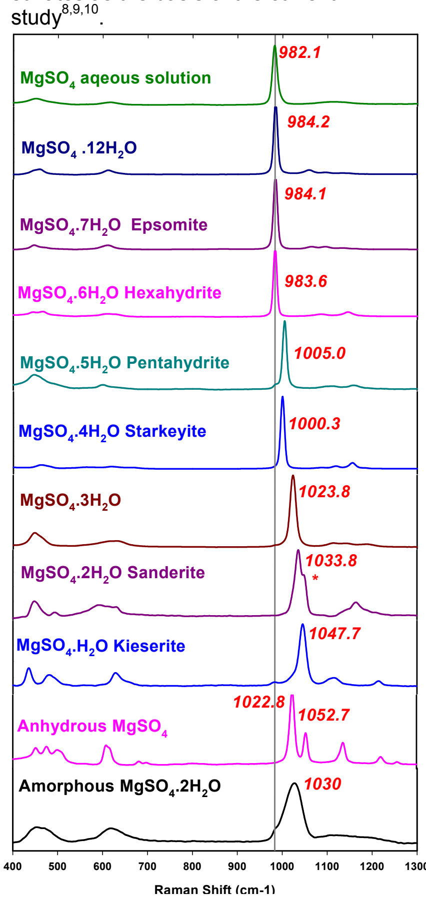
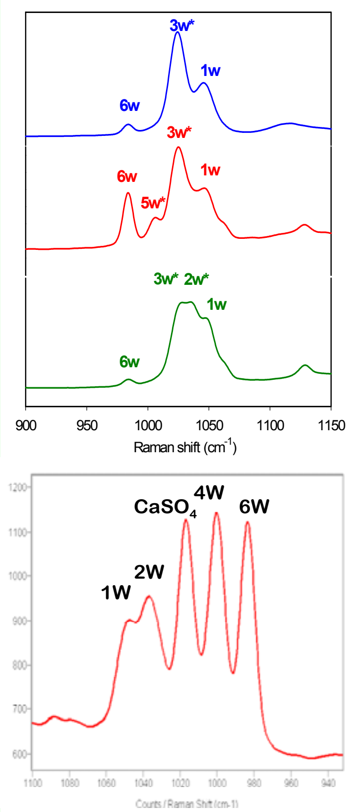


Figure 2. (a) Raman spectra of Mg-sulfate mixtures; (b) 1w- & 2w- (in addition to 4w-) $MgSO_4$ can be produced from the dehydration of hexahydrite, when it is first mixed with Ca-sulfates.



References: [1]. Klingelhöfer et al., 2004, Science; [2] Haskin et al., 2005, Nature; [3] Wang et al., 2006a, JGR; [4] Bibring et al., 2005 Science; [5] Gendrin et al., 2005, Science; [6] Arvidson et al., 2005 Science, [7] Feldman et al., 2006 JGR., [8] Wang et al., 2006b, 37th LPSC; [9] Wang et al., 2006c, 37th LPSC; [10] Wang et al., GCA, in press.