PRELIMINARY RESULTS OF WATER QUANTIFICATION FOR AMORPHOUS FERRIC SULFATE RELEVANT TO MARS. Fan Meng[1], Erbin Shi[1], Changqing Liu[1], and Zongcheng Ling[1,2*] [1]Shandong Provincial Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, Institute of Space Sciences, Shandong University, Weihai, Shandong, 264209, China. [2]Key Laboratory of Lunar and Deep Space Exploration, CAS.(zcling@sdu.edu.cn).

Introduction: The Mars Science Laboratory CheMin instrument has detected X-ray amorphous materials in Martian soils and rocks at Gale Crater, with the estimated abundance of ~15-75 wt.% [1]. Amorphous ferric sulfate may be a candidate, which are often generated from the rapid dehydration of fully deliquescent crystalline sulfate or saturated ferric sulfate brines [2]. Therefore, if amorphous iron sulfate is found on Mars, it would mean a combination of hydration and rapid dehydration, which can be used to constrain the fluids and atmospheric conditions of Mars when they are formed [3]. Determining the water content of amorphous ferric sulfate could help us to better constraint the abundance of water in amorphous ferric sulfate using their spectra.

In this work, 6 amorphous ferric sulfates with different hydration degrees were synthesized using rapid dehydration of ferric sulfate brine at a high temperature, and were characterized using Lase Induced Break Down Spectroscopy (LIBS), and X-ray diffraction (XRD) to quantify H content of amorphous ferric sulfates, with intent to obtain the relationship between water contents and different spectral datasets.

Synthesis of amorphous ferric sulfate: The hydrated ferric sulfate powder was firstly put into an oven and heated at 200 ℃ for 3 days in the air to generate anhydrous ferric sulfate mikasaite [4]. Subsequently, mikasaite was dissolved in deionized water to obtain a saturated solution of ferric sulfate. The solution was put into 6 petri dishes, and the amount of the solution in each petri dish is controlled to be the same. The petri dishes were put into an oven and heated at different temperatures (120 ℃-50 ℃) for different time (0.5 h-48 h), making the solution rapid dehydration at high temperature and finally a light-yellow transparent solid was generated (Figure 1).

XRD was used to identify amorphous ferric sulfate samples. Finally, the water content in the sample was determined by thermogravimetry, and the mass of the sample was measured. The sample was heated in a 200-degree incubator for 2 days to make it completely dehydrated, and its mass was weighed again to determine the water content of the original amorphous sample. Finally, 6 different phases were synthesized, quantity of constitution water varies from 6.2~11.3 (i.e., $Fe_2SO_4 \cdot 6.2H_2O$ ~ $Fe_2SO_4 \cdot 11.3H_2O$).

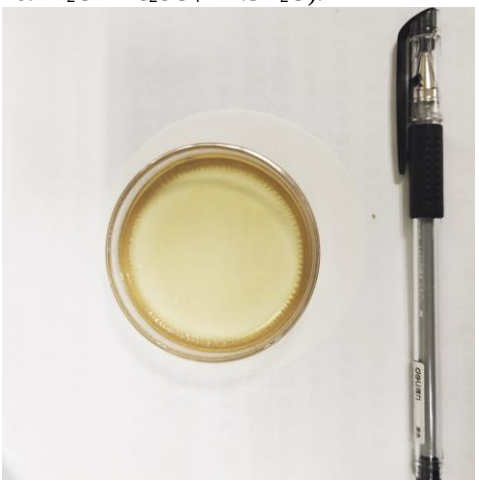

Figure 1. Image of amorphous ferric sulfate.

Results and discussion: The XRD measurement results (Figure 2) show that the X-ray diffraction pattern has no sharp peaks, and only shows a broad peak centered at 26 °~30 °, indicating that these samples are amorphous iron sulfates.

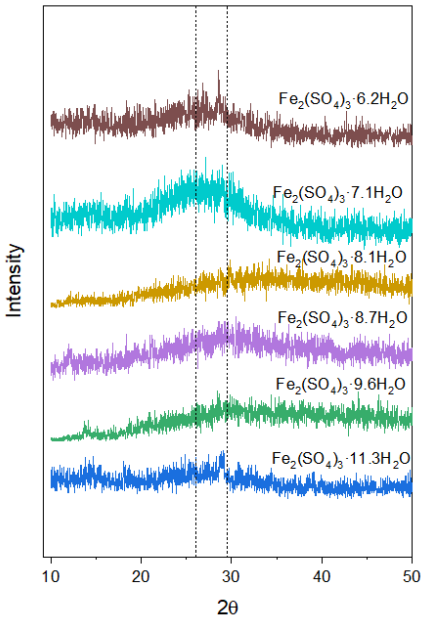

Figure 2. XRD patterns of amorphous ferric sulfates

The LIBS spectrum of an amorphous ferric sulfate with 6.2 water ($Fe_2SO_4 \cdot 6.2H_2O$) was measured using a laser of 200 mJ. The LIBS spectrum (Figure 3) has a clear H emission line at 656.5 nm, and a clear O line at 778.2 nm.

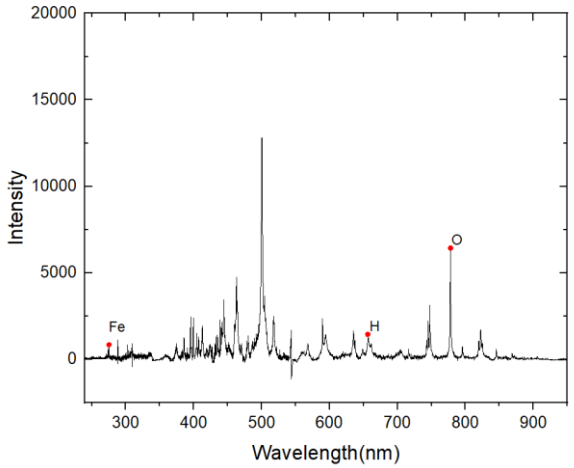

Figure 3. LIBS spectra of an amorphous ferric sulfate ($Fe_2SO_4 \cdot 6.2H_2O$).

Implication for Mars and future work: Both orbital and in-situ probes have detected the presence of ferric sulfate, but most Mars exploration missions reveal incomplete information about the extent of hydration of the amorphous sulfates. Identifying specific ferric sulfate relative to both Martian surface and atmospheric processes has important implications.

The next step is to synthesize a series of amorphous sulfates with different water contents, then LIBS and FT-IR spectroscopy are used to determine their H abundances and compared with thermogravimetric methods. The relationship between the amount of water and H intensity in the spectra will be helpful to better interpret Martian spectra of potential amorphous ferric sulfates.

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