

Table 1. Summary Parameter Mineral Indicators

Material	Primary Indicators (μm)	Secondary Indicators (μm)
Monohydrated sulfate	2.1 + 2.4	
Polyhydrated mineral	1.9	1.4
Polyhydrated sulfate	1.9 + 2.4	1.4
Ferric hydroxysulfate	2.238 (2.24)	1.48, 1.82, 2.38

member spectra were extracted from the CRISM spectra by inspection of band parameter maps and detailed examination of a large number of I/F and ratioed spectra where parameter maps indicated a relatively high abundance of a given mineral species.

[10] The imaging and spectral data sets were used in tandem to generate maps that show the locations of mineral identifications with CRISM data (Table 2), mineral identifications with OMEGA and TES data from previous work, and geologic units that contain the specific mineral signatures (Figures 2a and 2b). Gridded global topography data from MOLA (1 m vertical resolution) [Smith *et al.*, 2003] and digital elevation maps generated from stereo HRSC data (20–100 m vertical resolution) [Ansan *et al.*, 2008] were used in conjunction with the other data sets to define embayment and superposition relationships among the various units and to define the map units and stratigraphic relationships shown in Figures 2b and 3.

3.2. Laboratory Measurements

[11] To support spectral identification of sulfate-bearing minerals, visible and near-infrared (VNIR), Mössbauer (MB), and powder X-ray diffraction (XRD) measurements were acquired for synthetic melanterite ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$; Fisher Scientific) heated in air at 80°C, 110°C, 130°C, 150°C, 200°C, and 240°C for 2, 3, 18, 21, 21, 18 h, respectively. An Analogue Spectral Devices FieldSpec RS³ spectrometer with a Muglight option was used to obtain VNIR spectra at room temperature. Transmission Mössbauer spectra were obtained at room temperature with a Ranger Scientific spectrometer (Model MS-1200) using a ⁵⁷Co(Rh) source and analyzed using the methods outlined by Morris *et al.* [2000]. The values of the doublet Mössbauer parameters isomer shift ($\delta = (\nu_1 + \nu_2)/2$) and quadrupole splitting ($\Delta E_Q = \nu_1 - \nu_2$) were calculated from the center positions (ν_1 and ν_2 with $\nu_2 > \nu_1$) of the two peaks. The value of δ is reported relative to the center position of the spectrum of

metallic iron foil at room temperature. A Scintag XDS 2000 X-ray diffractometer using $\text{CuK}\alpha$ radiation and a step size of 0.02° 2 θ was employed to obtain X-ray diffraction powder patterns (~293 K). On the basis of XRD patterns, the powders obtained by thermal decomposition of synthetic melanterite at 80°C and 240°C are synthetic szomolnokite ($\text{FeSO}_4 \cdot \text{H}_2\text{O}$) and ferric hydroxysulfate ($\text{Fe}(\text{OH})\text{SO}_4$), respectively. VNIR and MB spectra of the synthetic melanterite, szomolnokite, and ferric hydroxysulfate are shown in Figure 5. As will be shown in section 4, melanterite is an example of a polyhydrated phase that matches CRISM-based spectra and szomolnokite is a possible match for the monohydrated phase in Aram Chaos. $\text{Fe}(\text{OH})\text{SO}_4$ can be identified as a specific phase based on detailed comparison of CRISM-based and our laboratory data, as shown in Figure 4.

4. Stratigraphy and Mineralogy of Sedimentary Deposits

[12] Two major stratigraphic units unconformably overlying the basaltic basement chaos terrain were mapped in detail as part of our work (Figures 2b and 3). The chaos terrain beneath and surrounding the sedimentary deposits was described elsewhere in detail and will not be covered in this paper [Glotch and Christensen, 2005; Oosthoek *et al.*, 2007; Massé *et al.*, 2008b; Noe Dobrea *et al.*, 2008]. CRISM spectra for the chaos surfaces are consistent with the presence of nanophase ferric oxides variably mixed with basaltic materials. Descriptions for the two overlying sedimentary units incorporate both the results of this study and previous work in this area and are described in this section from oldest to youngest. The areal extents of the units in CRISM and OMEGA/TES data are given in Table 3. As already noted, a schematic cross section showing the current topographic relationships of the sedimentary units and basement chaos materials is shown in Figure 3.

4.1. Ferric Hydroxysulfate, Monohydrated Sulfate, and Nanophase Ferric Oxide Unit

[13] The first of the two sedimentary units has three distinctly different stratigraphic horizons. From oldest to youngest these are monohydrated sulfates with ferric hydroxysulfate, monohydrated sulfates, and monohydrated sulfates with nanophase ferric oxides. The changing mineralogy represents a facies change and likely temporal evolution in the environments of deposition and/or alteration.

Table 2. CRISM Targeted Observations Used in This Paper^a

Observation ID	Type	Day of Year ^b	Center Latitude/Longitude	Ls
HRL0000646A	Half resolution long	2007_169	2.99°N, 339.62°E	259.9
FRT00007FA4	Full resolution targeted	2007_274	2.91°N, 339.42°E	323.3
HRL000087E6	Half resolution long	2007_302	2.40°N, 340.21°E	338.5
FRT00008EB6	Full resolution targeted	2007_357	3.34°N, 340.08°E	6.8
FRT00009496	Full resolution targeted	2008_008	3.92°N, 338.82°E	14.8
FRT000098B2	Full resolution targeted	2008_020	3.92°N, 339.50°E	20.1
FRT0000AB75	Full resolution targeted	2008_126	3.66°N, 338.58°E	67.6
FRT0000C14E	Full resolution targeted	2008_231	3.41°N, 339.12°E	114.6
FRT0000C815	Full resolution targeted	2008_259	3.41°E, 339.44°E	127.6
FRT0000D26B	Full resolution targeted	2008_303	3.41°N, 339.59°E	149.4

^aObservations are listed in chronologic order.

^bDate format is year_day.