



Figure 5. (a) VNIR and (b) Mössbauer spectra at room temperature for synthetic melanterite [$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$], szomolnokite [$\text{FeSO}_4 \cdot \text{H}_2\text{O}$], and ferric hydroxysulfate [$\text{Fe}(\text{OH})\text{SO}_4$] were obtained by thermal decomposition of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in air at 80°C and 240°C, respectively. For $\text{Fe}(\text{OH})\text{SO}_4$ in Figure 5a, the spectral features at 1.49, 1.83, 2.24, and 2.38 μm are associated with Fe^{3+} -OH vibrations, and the spectral features at 0.43 and 0.97 μm are associated with Fe^{3+} electronic transitions. The Mössbauer parameters (δ and ΔE_Q) in Figure 5b are characteristic of octahedrally coordinated Fe^{2+} ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ and $\text{FeSO}_4 \cdot \text{H}_2\text{O}$) and octahedrally coordinated Fe^{3+} ($\text{Fe}(\text{OH})\text{SO}_4$).

4.1.1. Ferric Hydroxysulfate, Monohydrated Sulfates

[14] The sedimentary section sitting directly and unconformably on the chaos bedrock surface is spectrally dominated by monohydrated-sulfate-bearing materials, but together with ferric hydroxysulfate-bearing materials exposed in a number of areas (Figures 2b, 3, and 4). Examination of these exposures with HRSC DEM data shows that these deposits in total are 50 to 75 m thick. The $\text{Fe}(\text{OH})\text{SO}_4$ -bearing material occurs in small exposures that are intercalated with deposits of monohydrated sulfate (Figure 6). In the CRISM observations in which this signature is detected at the edge of the sedimentary deposit (FRT8EB6 and FRT98B2), the material is found in contact with both the basement chaos blocks and monohydrated sulfate (Figure 6a; FRT8EB6 not shown). In the CRISM observations over the interior of the sedimentary deposit (HRL646A and FRT7FA4; Figure 6b), the $\text{Fe}(\text{OH})\text{SO}_4$ signature is only detected in areas where erosion has exposed the contacts between the sedimentary

material and the underlying basement chaos surfaces. Examination of HiRISE data (Figure 7) shows that areas with the $\text{Fe}(\text{OH})\text{SO}_4$ signature correspond to dark material that is cracked on a several meter scale and superimposed by the light-toned, monohydrated sulfate-bearing material. Although the $\text{Fe}(\text{OH})\text{SO}_4$ -bearing unit occurs in only four of the targeted CRISM observations over Aram Chaos, areas with similar morphology in CTX data not covered by CRISM observations suggest that its occurrence is more extensive.

[15] The $\text{Fe}(\text{OH})\text{SO}_4$ interpretation above is based on a spectral absorption at 2.238 μm , coupled with minor absorptions at 1.49, 1.82, and 2.38 μm (Figure 4). The 2.238 μm absorption is accompanied by a distinct spectral shape just shortward of 2.24 μm . The nondetection of a band centered at 1.40 μm indicates that structural H_2O is not present at detectable levels. This material was previously mapped by both *Massé et al.* [2008b] and *Lichtenberg et al.* [2008] and interpreted to be an Al-OH bearing mineral by *Massé et al.* [2008a]. As noted previously in this paper, synthetic melanterite ($\text{Fe}^{+2}\text{SO}_4 \cdot 7\text{H}_2\text{O}$) was heated in laboratory air at $\sim 240^\circ\text{C}$ for 21 h, resulting in production of H_2O and H_2 by-products, Fe^{+3} from oxidation of Fe^{+2} , and formation of $\text{Fe}(\text{OH})\text{SO}_4$. VNIR laboratory spectrum of the synthetic $\text{Fe}(\text{OH})\text{SO}_4$ is shown compared to the ratioed CRISM spectrum of this material in Figure 4. Figure 5 shows the synthetic melanterite, szomolnokite, and ferric hydroxysulfate VNIR spectra along with Mössbauer spectra confirming the transition from Fe^{+2} from synthetic melanterite to Fe^{+3} as the sample was heated and converted to ferric hydroxysulfate. The VNIR spectra also show the shift of the ~ 1.9 μm absorption due to H_2O in the melanterite to ~ 2.1 μm in the szomolnokite. The spectra of the ferric hydroxysulfate in Aram Chaos are similar to the spectra of dehydrated ferricopiapite reported by *Milliken et al.* [2008] and *Bishop et al.* [2009], although their data show neither an absorption at 1.82 μm nor the distinctive spectral structure shortward of 2.24 μm . The Aram Chaos ferric hydroxysulfate is also distinct from the ferric-bearing sulfates found at Gusev crater and Meridiani Planum on the basis of Mössbauer data (Figure 5 and *Morris et al.* [2006a, 2006b, 2008]).

4.1.2. Monohydrated Sulfates

[16] Above approximately 75 m above the contact with the underlying chaos bedrock, the sedimentary deposit transitions without any major unconformities to a mono-

Table 3. Unit Characteristics

Compositional Information	Extent of Coverage With CRISM Data	Extent of Coverage With OMEGA Data
polyhydrated sulfate ^a ; crystalline hematite ^b ; enhanced hydration; ferric oxides	170 km ²	~ 2770 km ²
nanophase ferric oxides; monohydrated sulfate ^a	-	4600 km ²
monohydrated sulfate ^a	200 km ²	~ 1185 km ²
ferric hydroxysulfate; monohydrated sulfate ^a	18 km ²	-

^aAlso detected with OMEGA data.

^bDetected with TES data [*Christensen et al.*, 2001; *Glotch and Christensen*, 2005].