



**Figure 3.** Schematic cross section derived from mineralogic, morphologic, and topographic data and covering all described units of the sedimentary deposit. MOLA elevations are in meters below reference areoid. The monohydrated sulfate and ferric hydroxysulfate are shown in the stratigraphic column as discrete deposits, but the contact between them is likely gradational. On the other hand, the boundary with the polyhydrated material is an unconformity separated by a period of erosion.

inferences of the various layered units superimposed on the basement chaos materials.

[6] CRISM is a hyperspectral imager that can acquire up to 544 spectral channels between 0.39 to 3.9  $\mu\text{m}$  with two detectors: a short-wavelength detector that functions between 0.39 and 1.04  $\mu\text{m}$  (S detector) and a long-wavelength detector that functions from 1.0 to 3.9  $\mu\text{m}$  (L detector) [Murchie *et al.*, 2007]. CRISM has two operational modes: a hyperspectral targeted mode (FRT, HRL, and HRS) and a multispectral nadir-looking mode (MSP). The multispectral mode is designed to provide mineralogical information for as much of the surface as possible, whereas the hyperspectral mode is designed to probe the mineralogy of relatively small areas in great detail. In the hyperspectral mode, gimbaling allows the instrument to be pointed at specific locations to the left or right of the spacecraft track while acquiring data at full spectral (544 bands, 0.39–3.9  $\mu\text{m}$ ) resolution and either full or half spatial resolution ( $\sim 18$  or  $\sim 40$  m/pixel, respectively) [Murchie *et al.*, 2007]. Multiple images are taken on the incoming and outgoing spacecraft track to sample different path lengths through the atmosphere, but in this paper only the center observation is used. Targeted observations cover  $\sim 1300$  km<sup>2</sup> of the sedimentary deposit in Aram Chaos.

[7] CRISM data presented in this paper were converted to I/F by dividing radiance on sensor by the solar radiance. Atmospheric gas band absorptions were removed by normalizing to a gas transmission spectrum. This spectrum, from data acquired over Olympus Mons where the surface spectra are dominated by dust signatures, is obtained by dividing I/F values at the base of Olympus Mons by values at the summit. The variation in atmospheric path length from the base to the top of the volcano provides a transmission spectrum which can then be used to remove gas features from other spectra. This method has been used extensively in reduction of hyperspectral data [Langevin *et al.*, 2005; Mustard *et al.*, 2005; Lichtenberg *et al.*, 2007], and here is applied to L detector data only because that is the spectral region in which atmospheric gas bands are present. At

wavelengths shorter than  $\sim 1$   $\mu\text{m}$ , atmospheric effects are dominated by aerosols and we did not correct for these effects. Both L and S detector observations were photometrically corrected by dividing by the cosine of the incidence angle for each observation. Spectra of candidate mineral locations were also divided by a spectrum from within the same CRISM data set that is spectrally neutral in order to suppress remaining instrument artifacts. Specifically, the denominator spectra were chosen from nearby regions that are spectrally flat between 1 and 2.5  $\mu\text{m}$ . For reference, Figure 4 shows the end-member spectra for each of our units identified from CRISM data, along with the neutral spectra used to generate ratioed spectra. For comparison purposes, Figure 4 also presents the ratioed versions of the spectra along with laboratory analogs discussed in section 3.2.

[8] Initial mineral detections were made using CRISM summary products generated with the ENVI plug-in CRISM Analysis Tool (CAT) [Pelkey *et al.*, 2007]. The spectral parameter summary products take advantage of unique absorptions or combinations of spectral features that some minerals have in the visible/near-infrared wavelengths, and are a first-order tool for identifying locations to explore in greater detail with the full wavelength range of the data set. For example, most hydrated sulfates have a spectral feature at 2.4  $\mu\text{m}$  [Cloutis *et al.*, 2006], and, therefore, a mathematical expression which takes into account the overall slope of the spectrum in that wavelength region and the actual absorption at 2.4  $\mu\text{m}$  can be used to identify the possible signature of sulfates in a spectrum [Pelkey *et al.*, 2007]. Multiple parameters can be used together to identify monohydrated sulfates (absorptions at both 2.1 and 2.4  $\mu\text{m}$ ) or polyhydrated sulfates (absorptions at 1.4, 1.9, and 2.4  $\mu\text{m}$ ). Initial detections of hydrated minerals within the layered deposits were made over Aram Chaos using the spectral parameters or combinations of spectral parameters indicated in Table 1. A new parameter algorithm was developed after examination of both I/F and ratioed data showed the pres-