

**FIRST CRISM OBSERVATIONS OF LAYERED MATERIAL IN WESTERN CANDOR CHASMA.** S. Murchie<sup>1</sup>, J.-P. Bibring<sup>2</sup>, J. Bishop<sup>3</sup>, D. Humm<sup>1</sup>, R. Milliken<sup>4</sup>, J. Mustard<sup>5</sup>, S. Pelkey<sup>5</sup>, L. Roach<sup>5</sup>, F. Seelos<sup>1</sup>, K. Seelos<sup>1</sup>, and the CRISM Science Team, <sup>1</sup>Applied Physics Laboratory, Laurel, MD ([scott.murchie@jhuapl.edu](mailto:scott.murchie@jhuapl.edu)), <sup>2</sup>Institute d'Astrophysique Spatiale (IAS), Orsay, France, <sup>3</sup>NASA/ARC, Moffett Field, CA, <sup>4</sup>NASA/JPL, Pasadena, CA, <sup>5</sup>Brown University, Providence, RI.

**Introduction:** The first CRISM images of layered material in western Candor Chasma reveal significant spectral diversity within the deposits. Some layers are relatively unaltered and rich in pyroxene, and others are more oxidized. Monohydrated sulfate such as kieserite is widespread in occurrence, but strongly concentrated in relatively low albedo layers. The greatest concentrations of fine-grained iron oxides occur in accumulations of mass wasted debris.

**Background:** The Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) is a hyperspectral imager on the MRO spacecraft [1]. Separate images obtained by visible/near-infrared (VNIR) and infrared (IR) detectors together cover the wavelength range 362-3920 nm in 544 channels at 6.55 nm/channel. CRISM operates in both mapping and targeted modes. In targeted mode, the camera is scanned to remove most along-track motion, and a region of interest is mapped at full or half spatial resolution (~18 or ~36 m/pixel) and full spectral resolution. In mapping mode, data are binned to 100-200 m/pixel, and 72 channels selected for the characterization of key mineralogic absorptions are returned.

The layered materials of Valles Marineris are controversial in their origin. Proposed mechanisms include subaerial fluvial deposition or volcanism [2], accumulation by airfall [3], lacustrine precipitation [4], hydrovolcanism [5], and erosional remnants of the chasma wall materials [6]. Observations by the Mars Express/OMEGA imaging spectrometer showed that they contain sulfates, occurring both as a monohydrate and as polyhydrates, segregated into different parts of the deposits [7-8]. The sulfates occur in close spatial association with fine-grained ferric oxides having distinctive VNIR absorptions [9].

**Overview of CRISM Results:** Through 1 January 2007, the layered deposits of western Candor had been imaged in 3 locations using targeted observations, and over ~20% of their extent in mapping mode. Two of the targeted images are shown in Figures 1-4. Individual layers are resolved, and appear highly variable in their spectral properties. At visible wavelengths (Figures 1 and 3) most layers grade between bright, reddish, and dust-like and a darker, grayer color. Some locations exhibit an enhanced 530-nm ferric absorption; these are not well-developed layers, but instead show evidence for formation by mass wasting (association with downslope

streaks, Figure 1, and location at the base of a steep slope, Figure 3). Materials with the strong 530-nm absorption typically also exhibit a 900-nm band indicative of a fine-grained, crystalline ferric phase (green spectrum, Figure 5).

At IR wavelengths, grayer materials are diverse. Some show evidence for distinct 1- $\mu$ m and 2- $\mu$ m absorptions characteristic of high-Ca pyroxene (black spectra in Figure 6; blue areas in Figures 2 and 4), while others lack pyroxene absorptions (red spectrum in Figure 6). Some of the grayer layers exhibit 1500- and 2100-nm absorptions indicative of monohydrated sulfate (green spectrum, Figure 6; green layers in Figures 2 and 4). The materials with a strong 530-nm and a 900-nm ferric absorption (reddish materials in Figures 1 and 3) typically also exhibit 1500- and 2100-nm sulfate absorptions (green areas on the steep slope in Figure 2, at the break in slope in Figure 4).

**Discussion:** The layers in western Candor Chasma exhibit variation in their degree of alteration. This diversity, and the concentration of sulfate in discrete layers, may indicate environmental variation during formation of the layered deposits. More imaging is required to assess variations within individual layers, and to more completely map the deposits.

The concentration of fine-grained ferric minerals in mass wasted debris is consistent with the hypothesis of Gendrin *et al.* [9]. They conjectured that the sulfates formed with gray hematite - which is optically opaque at CRISM's wavelengths - as at the MER/Opportunity landing site, and that abrasion of the gray hematite during mass wasting formed finer grains that are optically active at 400-1000 nm.

**References:** [1] Murchie, S. *et al.* (2006) *J. Geophys. Res.*, in press. [2] Lucchitta, B. *et al.* (1992) in *Mars* (H. Kieffer, et al., Eds.), pp. 453-492, Univ. of Arizona Press, Tucson. [3] Peterson, C. (1981) *Proc. Lunar Planet. Sci. Conf. XII*, 1459-1471. [4] McKay, C. and S. Nedell (1988) *Icarus*, 73, 142-148. [5] Nedell, S. *et al.* (1987) *Icarus*, 70, 409-441. [6] Edgett, K. and M. Malin (2003) *Lunar and Planetary Science XXXIV*, #1124. [7] Gendrin, A. *et al.* (2005) *Science*, 307, 1587-1591. [8] Mangold, N. *et al.* (2006) Workshop on Martian Sulfates as Recorders of Atmospheric-Fluid-Rock Interactions, #7039. [9] Gendrin, A. *et al.* (2005) *Lunar and Planetary Science XXXVI*, #1378.

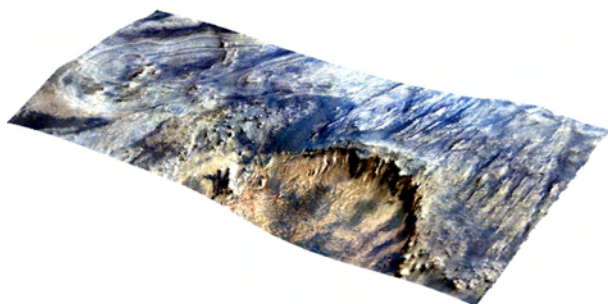


Fig.1. 3-color composite constructed from 592-, 533-, and 442-nm data, stretched to accentuate color variations, and draped over MOLA topography with 4x vertical exaggeration. White areas are dust-like in their spectral properties, reddish areas have a strong 530-nm band characteristic of fine-grained ferric minerals, and gray areas are less rich in fine-grained ferric minerals. The scene is 11 km across at the narrowest. Image ID HRL00002831\_07.

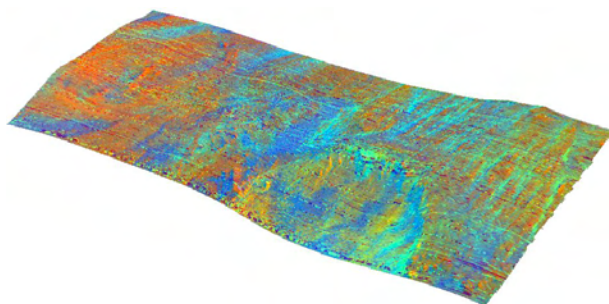


Fig. 2. False color image showing IR spectral variations, draped over MOLA topography with 4x vertical exaggeration. R = 1330-nm I/F, G = depth of the 2100-nm absorption due to monohydrated sulfate, B = integrated depth of the 1- $\mu$ m mafic mineral absorption.

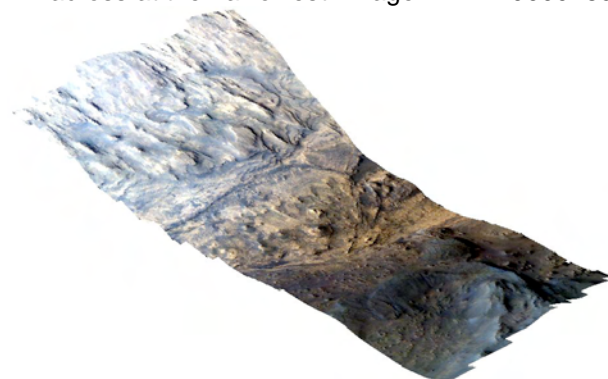


Fig.3. Similar color composite to Figure 1. The scene is 11 km across at the narrowest. Image ID HRL000033B7\_07.

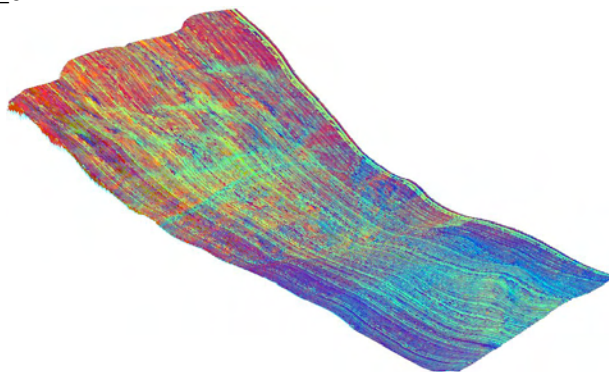


Fig. 4. Similar color composite to Figure 2. Image ID HRL000033B7\_07. Striping from upper left to lower right is due to uncorrected instrument artifacts.

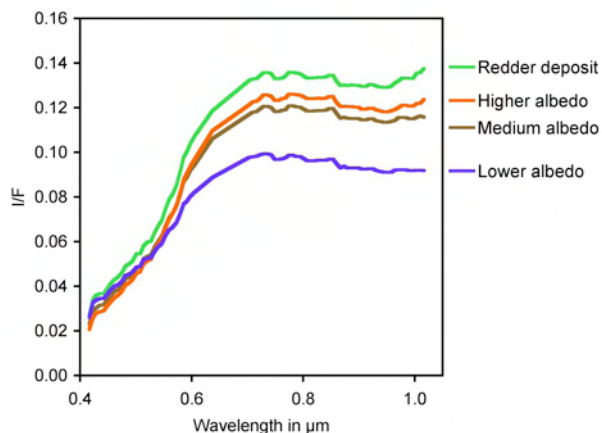


Fig. 5. Spectra of different Candor materials from the visible/near-infrared (VNIR) detector.

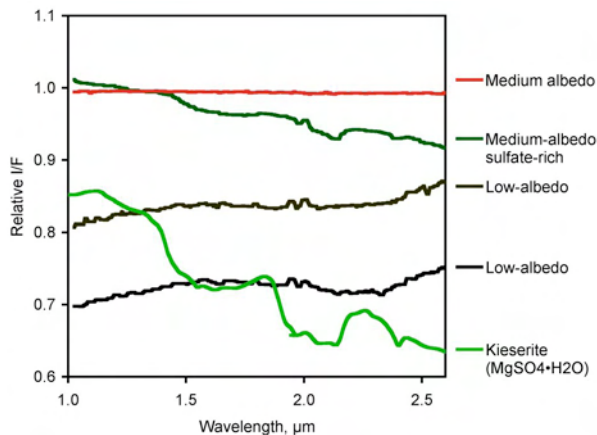


Fig. 6. Spectra of different Candor materials from the infrared (IR) detector. Spectra have been corrected for atmospheric gas absorptions, and ratioed to an intermediate albedo material to highlight spectral differences.