

AQUEOUS MINERALOGY RECORDED IN COPRATES CATENA, MARS. P. M. Grindrod^{1,2} and M. West¹, ¹Department of Earth Sciences, UCL, Gower Street, London, UK, ²Centre for Planetary Sciences, UCL, Gower Street, London, UK. (p.grindrod@ucl.ac.uk)

Introduction: We have studied an area of light-toned deposits (LTDs) within a closed trough of Coprates Catena, about 80 km south of the main Coprates Chasma rift system. The LTDs are located on the floor of a trough that is approximately 47 km long and 15 km wide. This trough has a minimum elevation of about 60 m, giving a total depth from the top of the trough walls to the floor to of about 3.4 km. This trough has been the focus of previous studies [1,2] because of the distinctive terraced fan deposit, apparently fed by a contributory valley, which lies towards the center of the trough. Although both these previous studies suggest that the fan is a terminal deposit of fluvial activity along the incised valley, they disagree on the exact formation mechanism: [1] argue for an alluvial, sheetflood-dominated deposition, whereas [2] prefer a deltaic deposition process. The implications of these different scenarios are important because they determine whether there was ever a standing body of water in the trough, and one of the aims of this study is to contribute to this debate.

Data and Methods: We prepared a 1 m Digital Elevation Model (DEM) from HiRISE stereo pair PSP_007917_1650 and PSP_009631_1650 using the method of [3]. We also created CTX stereo DEMs using a similar method. Where possible we carried out structural mapping of the DEM using the method of previous studies [e.g. 4-6].

We analyzed a single Compact Reconnaissance Imaging Spectrometer for Mars (CRISM: [7]) image that covered the study area (FRT00011DF2). We used the commercial software package ENVI with the CRISM Analysis Toolkit plug-in (CAT: [8]). We use the standard protocol for processing our CRISM data, which is described in detail in previous studies [e.g. 7]. We analyze this CRISM image using three different methods. Firstly, spectral parameter summary products were generated in CAT [8] and used for initial mapping of different hydrated and/or hydroxylated terrains. Secondly, the results of the spectral summary product analysis were verified by collecting spectra for specific regions of interest (RoI) by averaging a number of pixels from a single unit. The absorption signatures were enhanced by ratioing against a spectrally-bland region [e.g. 9-12]. Finally, to ensure that mineral identifications from RoI spectra were robust, we collected spectra from each unit from the non map-projected image by taking the average values of 3 pixels, and ratioing these spectra against 3 pixel averages of spectrally bland regions in the same detector column.

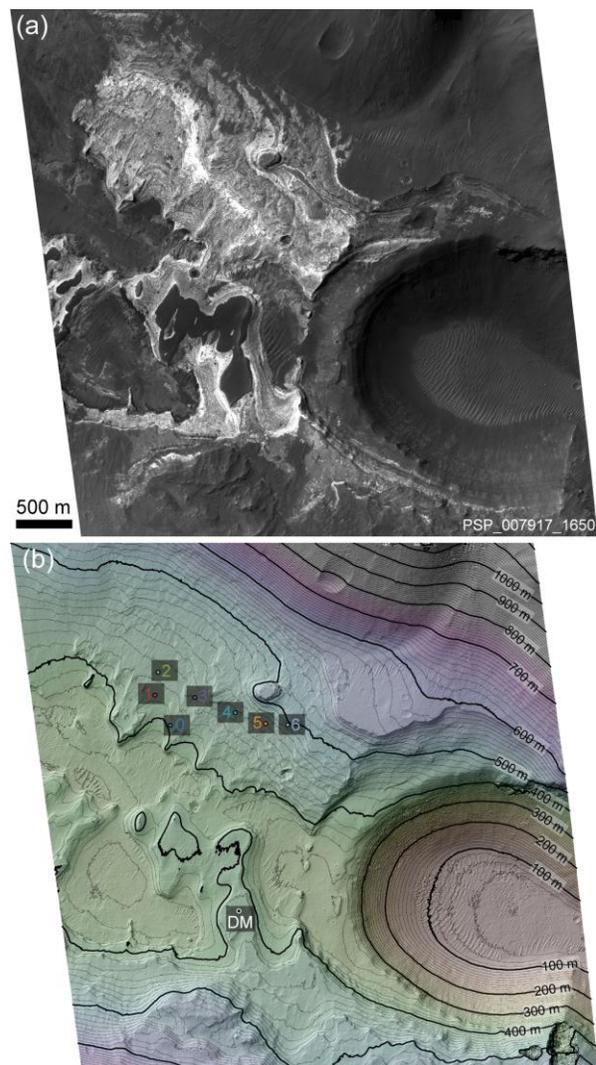


Figure 1. The LTD study area. (a) Orthorectified HiRISE image PSP_007917_1650. Colorized hillshade of the 1 m DEM made as part of this study. Contours are labeled every 100 m and drawn every 10 m.

HiRISE Observations: The general direction of dip of the bedding mimics that of the trough with a mean strike of 154° . Measurements of the bedding orientation reveal that layers generally dip gently to the center of the trough, with dip angles of between 1 and 13° , also mimicking the slope of the trough walls. These low dip angles mean that if our orientation measurements are correct, then the true thickness of the layers is similar to the apparent thickness. Our orientation measurements suggest that the higher elevations generally have larger dip angles. We used the 25

cm/pixel orthorectified HiRISE image to identify morphological features that correlated with key CRISM spectral locations.

CRISM Observations: The LTDs are bright at 1330 μm , are distinct from the surrounding dusty surface and show layered variation in color in the near-infrared. The strongest hydration signals are found in the vicinity of the LTDs, and particularly in areas lacking dark mantling material. There is an apparent variation in absorption wavelength that depends on elevation, which we investigate by taking spectral profiles through the most well-defined outcrop sequence of the LTDs in the western side of the northern base of the trough. In general, there is a strong hydrated mineral signal at elevations from about 370 to 550-600 m.

We took spectra at elevations that marked out apparent spectrally-distinct units, both as 3 pixel averages and larger RoIs. All spectral ratios in the LTD sequence show absorptions around 1.9 μm , indicative of the presence of H_2O molecules, either trapped, absorbed, adsorbed, or bound in this layered sequence [e.g. 13], and so we use other characteristic absorption features where possible to elucidate the nature of the water-containing deposits. Our spectral ratios show variations in the absorption depths at the characteristic wavelengths, rather than a change over the entire wavelength range, suggesting that at least the surface of the LTDs are not phase pure, but instead are mixtures dominated by different materials at different locations and elevations.

The primary characteristics that we use to monitor this change are the relative strength of absorptions at wavelengths around 2.20 and 2.30 μm ; absorptions around 2.20 μm can be caused by OH bond vibrations in Al -rich phyllosilicates, whereas absorptions around 2.30 μm can be the result of OH bound to Fe and/or Mg [e.g. 9,13]. From the base of the LTDs (~350 m) to about 410 m the CRISM data suggest the presence of general hydrated minerals, with the absorption feature at 2.20 μm possibly indicative of Al phyllosilicate group minerals such as montmorillonite. At elevations between about 410 and 425 m, the marked increase and decrease in absorption at 2.30 and 2.20 μm respectively suggests that Fe - and/or Mg -rich phyllosilicates, such as nontronite or saponite, could be dominant. At elevations between about 425 and 480-500 m, the 2.30 μm absorption has become less significant than the 2.20 μm absorption, suggesting a transition to Al -rich phyllosilicates. At elevations above about 480-500 m, the broad absorption at 2.20 μm , possible absorption at 2.41 μm and the gradual transition of the absorption center from 1.92 to 1.94 μm could be indicative of a sulfate hydrate-dominant layer, particularly monohydrated phases such as anhydrite.

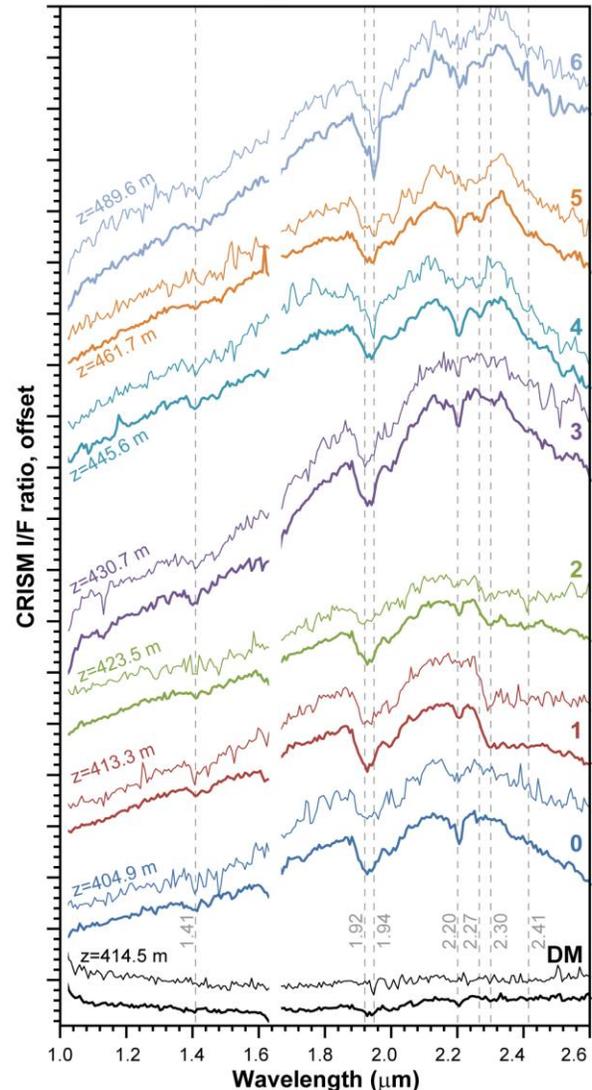


Figure 2. CRISM spectral ratios at different elevations shown in Figure 1b. Thick lines represent the ROI spectra and thin lines represent the individual spectra (3 pixel average). DM is dark mantling material and does not form part of the CRISM sequence study.

References: [1] Di Achille, G. et al. (2006) *GRL* 33, L07204. [2] Weitz, C.M. et al (2006) *Icarus* 184, 436-451. [3] Kirk R.L. et al. (2008) *JGR* 113, E00A24. [4] Fueten, F. et al. (2005) *Icarus* 175, 68-77. [5] Fueten, F. et al. (2008) *JGR* 113, E10008. [6] Okubo, C.H. (2010) *Icarus* 207, 210-225. [7] Murchie, S. et al. (2007) *JGR* 112, E05S03. [8] Pelkey, S.M. et al. (2007) *JGR* 112, E08S14. [9] Bishop, J.L. (2008) *Clay Miner.* 43, 35-54. [10] Mustard et al., J.F. (2008) *Nature* 454, 305-309. [11] Milliken, R.E. et al. (2008) *Geology* 36, 847-850. [12] Milliken, R.E. et al. (2010) *GRL* 37, L04201. [13] Wiseman, S.M. et al. (2010) *JGR* 115, E00D18.