FANS AND PHYLLOSILICATES IN COPRATES CATENA, MARS. P. M. Grindrod[1,2], N. H. Warner[3], C. Schwartz[3], S. Gupta[4], [1]Earth Sciences, UCL, London, UK, [2]Centre for Planetary Sciences, UCL, London, UK, [3]Jet Propulsion Laboratory, Caltech, Pasadena, USA, [4]Department of Earth Science & Engineering, Imperial College London, London, UK (p.grindrod@ucl.ac.uk).

Introduction: We have studied two fan systems and associated deposits in two separate but adjacent closed troughs in Coprates Catena. By combining HiRISE and CTX stereo Digital Elevation Models (DEMs) with CRISM multispectral data we attempt to understand the likely aqueous alteration history in terms of both the local and regional geological evolution. Previous hypotheses put forward specifically for the formation of one of our fan systems include end-member methods of alluvial, sheetflood-dominated deposition [1] or deltaic deposition [2] processes. Rapid water release events have also been suggested to account for the stepped appearance of other fan systems on Mars [3], although syntectonic deposition could also account for the stepped appearance [e.g. 4].

Data and Methods: We used stereo CTX and HiRISE observations to create DEMs of two different resolutions using ISIS and SocetSet software packages [5]. These DEMs were combined in a GIS environment with multi-spectral CRISM data processed using the CRISM Analysis Toolkit in ENVI [6,7].

Observations: Our study region is located in the Coprates Catena region of South-East Valles Marineris. The two study fans, hereafter named Fan 1 and Fan 2, are approximately 75 km apart, located in separate but adjacent closed troughs. Fan 1 is the most westerly of our study fans, lying on the floor of 15 x 47 km closed trough oriented roughly east-west that has a maximum depth of approximately 3.4 km. Fan 2 lies on the floor of another closed trough, although with shallow, connecting depressions to the trough containing Fan 1, which is approximately 21 x 47 km with a maximum depth of about 3.5 km. Both troughs have channel-like features that cut into the surrounding plains and appear to terminate in the trough depressions.

Geomorphology and Structure. Both fans are made up of material that lies at the end of a channel and is deposited in the base of a closed trough. The fan deposits can be split into proximal and distal units based upon their layering characteristics and structure. The trough floors contain a variety of similar features, such as slump blocks, layered material, light-toned deposits, mantling material, impact craters and collapse features. Both fans have a distinctive stepped appearance, with individual layers dipping gently away from the source region in a direction aligned with the troughs. The layers in Fan 1 are exposed throughout the fan, whereas those in Fan 2 are confined to the proximal deposits. Neither of the stepped layer successions in the fans show any change in dip or strike as a function of elevation. Fan 1 is larger in size than Fan 2, with a length and height of 6.31 and 1.02 km respectively, compared to Fan 2 that has a length and total elevation drop of 4.37 and 0.48 km respectively. Using a method of manually removing the fan from the elevation datasets to derive a pre-fan surface [8], we calculate estimates of the volumes of Fans 1 and 2 of 6.1 and 0.8 km^3 respectively.

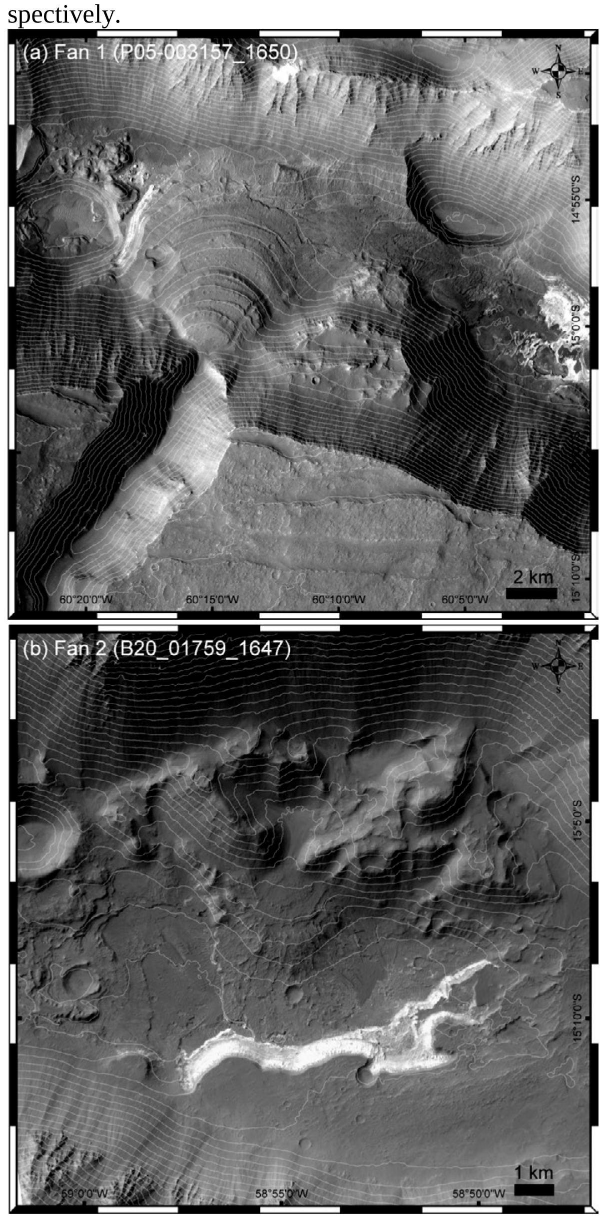

Figure 1. (a) Fan 1 and (b) Fan 2 in CTX images and 20 m/pixel stereo DEMs (contour intervals every 100 m).

Geochemistry. Our studies of the geochemistry of both fans are limited to a single half-resolution long CRISM observation (HRL0001B8AE) of a small area of Fan 2 and some light-toned deposits (LTDs). The overall dominant alteration spectral signature in this trough system is that of phyllosilicates, with distinctive absorption features at 2.3 μm, and some smaller areas having absorption features around 2.2 μm. Spectral parameter summary images highlight the distribution of these absorption features. The strongest alteration signatures centered around 2.3 μm are confined to LTDs exposed both in the bottom of the trough and in isolated outcrops in the walls at the top of the trough. The absorptions around 2.3 μm are strong throughout the LTDs, with a possible transition towards stronger absorptions centered around 1.9 μm towards the upper parts of the LTDs. Absorption features centered around 2.2 μm occur predominantly in LTDs located on the plains outside the trough, and in one location appear to be outcropping directly above the 2.3 μm material towards the top of the trough walls.

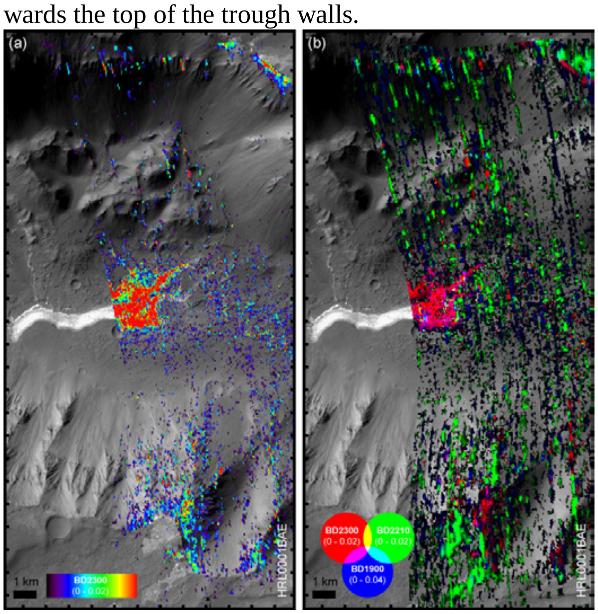

Figure 2. CRISM phyllosilicate parameter maps at Fan 2 overlain on a CTX base map. (a) Spectral parameter D2300, colorized to show band depth. (b) Spectral parameter image with the color planes R=D2300, G=BD2210, and B=BD1900.

Pixel spectra highlight not only the dominant signature of phyllosilicates, but also two possible different major types of phyllosilicates. LTDs have dominant absorption features at 2.3 μm, and also around 1.4, 1.93 and 2.4 μm, suggesting a mineralogy similar to Fe/Mg phyllosilicates such as saponite or nontronite. Similarly, the spectrum of material at the top of the trough wall also shows absorption features typical of Fe/Mg phyllosilicates. Material found outside the trough in the surrounding plains has a spectrum with an indicative broad absorption feature at 2.2 μm, with other absorptions at 1.4 and 1.9 μm, suggesting a mineralogy similar to Al phyllosilicates such as montmorillonite or kaolinite.

Crater Counting Surveys. To estimate the absolute age of different surfaces we used CTX images and standard crater counting techniques. A large area (26,000 km^2) count of craters > 100 m in diameter gave a model age of 3.7 Ga for the plains to the south-west of the troughs. We also counted all craters with diameters greater than 50 m in four smaller plains areas that surround the study troughs: two areas in the cratered plains and two areas in the inter-trough plains. In total we counted over 17,000 craters in an area of about 4000 km^2. In each case we derived a main model age, representing the bulk of the surface in a given area, but in two areas also derive additional model ages of possible resurfacing events suggested by kinks in the crater frequency histograms. Overall the main surface of each representative plains unit ranges in age from Middle Noachian (3.8 Ga) to Early Amazonian (2.6 Ga). There are two top-level age observations: (1) surfaces surrounding the trough at Fan 1 appear to be younger than those surrounding Fan 2, and (2) inter-trough surfaces appear to be older than cratered plains surfaces. Regardless of location, all surfaces in this study appear to have undergone some resurfacing or crater removal events, as indicated by kinks in the crater frequency histograms. In both the cratered plains units, these resurfacing events appear to be distinct enough to fit a model age of Late Amazonian (~900 Ma) from the crater count data. In the cratered plains surrounding Fan 2 there is an additional older possible surface present, with a model age of Middle Noachian (3.9 Ga).

Summary: The identification of possibly-related fans and phyllosilicates in the neighboring troughs of both Fan 1 [9] and Fan 2 suggests that fluvial and/or diagentic processes might have been widespread in this region of Valles Marineris. The likely Hesperian formation age of the closed troughs raises the importance of these fan-related phyllosilicates, particularly if the chemistry is indicative of in situ rather than externally-derived detrital material, which is unknown at present.

References: [1] Di Achille, G. et al. (2006) *GRL* 33, L07204. [2] Weitz, C.M. et al (2006) *Icarus* 184, 436-451. [3] Kraal et al. (2008) Nature, 451, 973-976. [4] Rohais S. et al. (2007) *Tectonophys.* 440, 5-28. [5] Kirk R.L. et al. (2008) *JGR* 113, E00A24. [6] Seelos, F. et al. (2011) LPSC 42, #1438. [7] Morgan, F. et al. (2011) LPSC 42, #2456. [8] Lucas A. et al. (2011) *JGR* 116, E10001. [9] Grindrod P.M. et al. (2012) *Icarus* 218, 178-195.