A MINERALOGIC AND MORPHOLOGIC ANALYSIS OF FOUR NEW PHYLLOSILICATE-BEARING MARTIAN FAN DEPOSITS. A.C.G. Hughes[1,2], D.M. Burr[1], J. E. Moersch[1], S.L. Murchie[2], D.L. Buczkowski[2], F.P. Seelos[2], K.D. Seelos[2]; [1]Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN (acghughes@gmail.com); [2]JHU/Applied Physics Laboratory, Laurel, MD.

Introduction: Fan-shaped deposits are an important key to understanding the geologic history of Mars, as the unique characteristics of these deposits can suggest possible formation in a lacustrine environment [e.g., 1-4]. High-resolution remote sensing observations from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), the High Resolution Imaging Science Experiment (HiRISE), and the Context Camera (CTX) on the Mars Reconnaissance Orbiter, have enabled detailed studies of these fans. Observations at several fans supporting a lacustrine origin include sub-horizontal layering, polygonal fracturing, and the occurrence of beds rich in phyllosilicates in fan deposits and their surroundings [5-8]. Phyllosilicates are of special interest because they can be formed or concentrated by sorting and redeposition, in lacustrine environments, and they are able to entomb organic materials [9].

Our study examines the 33 fans described by Irwin *et al.* (2005) [4], to test multiple hypotheses for the mechanisms that formed the fans (e.g., deltaic, alluvial fan, debris flow, volcanic flow, glacial deposition). All of the deposits discussed here are located at the mouths of valleys which incise crater rims, or in other topographic depressions hypothesized to be paleolake basins. This abstract presents the mineralogic and morphologic results for four fans newly identified to contain phyllosilicates (Fans #2, #21, #25, & #26, as named by [4]). Table 1 shows locations and data coverage of these fans.

Data and Methods: CRISM data (e.g. Figure 1) were used to analyze the mineralogy of all of the 33 fans identified by [4] and/or their nearby regions. Spectral indicators of major minerals were examined, and fans where phyllosilicates are detected were further characterized morphologically using HiRISE and CTX. Key diagnostic observations are the general morphology of the deposits (indicative of dominant formation processes), and the presence or absence of small-scale features associated with aqueous processes, including vertical stratification of layers (e.g., compositional layering), polygonal fracturing, large (HiRISE-resolvable) clast inclusions (indicating very poor sorting), inlet valleys, and fan distributary channels.

Observations and Interpretations:

Fan #26 Observations: Fe/Mg-phyllosilicates with absorption features at 1.4, 1.9, and 2.3 μm were previously identified on an elevated knob distal to this deposit [10]. We have now identified Al-phyllosilicates, with absorption features at ~1.4, ~1.9, and ~2.2 μm, in the lower beds of the fan. Al-phyllosilicates have also been identified surrounding the knob on which Fe/Mg-phyllosilicates were previously identified. From the top of this knob to its base, the strength of the absorption feature associated specifically with Fe/Mg-phyllosilicates (~2.3 μm) decreases and the strength of the feature associated with Al-phyllosilicates (~2.2 μm) increases.

In addition to the fan-shaped deposit characterized by [4], there is an older depositional feature which lies stratigraphically below fan #26. Both of these deposits exhibit small-scale horizontal layering in their lower beds, determined by apparent variations in material strength of the rock layers. Polygonally fractured units are present in beds of the fan toe, and large boulder-sized clast inclusions are apparent in lower beds of the fan. Heavily eroded, radially oriented negative relief features are present on the fan surface.

Fan #26 Interpretations: Vertical stratification of layering is inferred based on variations in material strength of the rock layers (possibly indicating compositional layering or differences in grain sizes), and radial gullies on the fan surface suggest the presence of fan distributary channels. This deposit is unique because it is the first fan deposit in which both Fe/Mg- and Al-phyllosilicates have been identified, possibly indicating different lithologies deposited during a single or multiple fluvial events, or altered in place. The abundance of aqueous morphology and the presence of phyllosilicates in lower beds and surrounding areas of this fan are consistent with, but not diagnostic of, deltaic processes in the formation of this deposit and the older, superimposed deposit, previously hypothesized to be a delta or an alluvial fan [11].

Fan #21 Observations: Newly identified phyllosilicates are exposed in high albedo regions near the toe of this fan. CRISM spectra are consistent with Fe/Mg smectite. Strong signatures of Fe/Mg-phyllosilicates are also present in the watershed from which the fan's inlet valley originates.

Small scale polygonal fractures are present in high albedo material distal to the fan toe and in upstream portions of the inlet valley.

Fan #21 Interpretations: Phyllosilicates are inferred to have been transported to this deposit due to the fact that they are present in both the lower beds of the fan and in the drainage basin. Polygonal fracturing and apparently segregated concentrations of phyllosilicates (and therefore, inferred smaller grain sizes) near the fan toe are consistent with fan formation in a deltaic environment, though this combination of morphology and mineralogy could also have been created in a fluvially-dominated alluvial fan [12].

Fan #25 Observations: This stair-stepped deposit contains newly-identified spectral signatures of Fe/Mg-phyllosilicates at ~1.9 and ~2.3 μm, but lacks a strong 1.4 μm feature. The strongest phyllosilicate signatures occur in a small, elongate depression located on a deposit superposing the southern edge of this fan.

Horizontal layering is present in the lower beds of the fan. Small scale polygonal fracturing is apparent in HiRISE images on/near multiple small mesas distal to the fan toe. Boulder-sized clast inclusions are present in the fan scarp.

Fan #25 Interpretations: This fan was previously hypothesized to be a delta based on morphologic and topographic similarities to terrestrial Gilbert-type deltas [13]. The fan appears to have been created by long-lived flow with a high sediment and/or water flux, as evidenced by large clast inclusions in the lower fan beds and a deeply incised inlet valley. Variations in material strength of layers suggest vertical stratification in distal fan regions, and possibly in the lower beds of the fan. The stair-stepped morphology of the fan may have resulted from shoreline erosion or the stacked deposition of multiple deposits, formed by changes in base level of the paleolake and/or changes in depositional intensity [4]. Reasons for the missing 1.4 μm feature are being explored.

Fan #2 Observations: This fan is located in a crater that contains two additional deposits hypothesized to be deltas or alluvial fans [14]. Phyllosilicates were previously identified in a layered, polygonally fractured unit in the center of the crater [10, 14]. Using newly acquired CRISM data, absorption features indicative of Fe/Mg-phyllosilicates have also been identified in basal layers of the southern toe of this deposit.

Variations in resistance of the exposed scarp indicate finely bedded layers. A variety of curvilinear features of negative and positive relief are present on the fan surface, including a wide, radially oriented, straight feature at the fan apex, and multiple sinuous ridges.

Fan #2 Interpretations: This deposit was previously hypothesized to be a Gilbert-type delta based on its steep sloping foreset beds (10-12˚) and gently sloping topset beds (<1˚) [14]. The wide negative relief feature near the fan apex is inferred to be an incised channel, and positive relief sinuous ridges are inferred to be inverted channels. The polygonal fracturing, horizontal bedding, and concentrations of phyllosilicates in the center of this crater support the hypothesis that Ismenius Cavus is a paleolake basin [4, 10, 14]. The presence of phyllosilicates in the inferred bottomset beds of this deposit, layering in the beds, and negative/positive relief fluvial features are consistent with deltaic depositional processes in the formation of this fan.

Conclusions: Analyses in this study are ongoing, but preliminary results show that at least four fans, in addition to those previously documented in Holden, Eberswalde, and Jezero craters [5-8], exhibit both morphologic and detectable mineralogic evidence consistent with formation in a persistent surficial liquid water (e.g., lacustrine) environment.

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Table 1: Locations and data coverage of fans

Fan	Depression Name	Lat.	Lon. (E)	CRISM	HiRISE
#26	Nepenthes Mensae	2.1	121.6	FRT147 E0 FRT16525	ESP_015980_1820
#21	Aeolis Mensae	-5.15	132.85	FRT64CE FRT1963E	PSP_001884_1750
#25	Unnamed	-39.2	-103.4	FRT944A	PSP_006798_1405
#2	Ismenius Cavus	33.9	17.5	FRT19B14	ESP_013531_2140

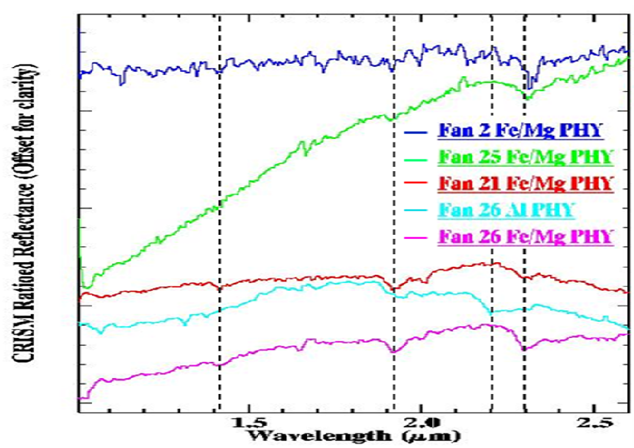

Figure 1: Spectra of Fe/Mg- and Al-phyllosilicates in/on fans, showing absorption features near 1.4, 1.9, and 2.2 μm (Al) or 2.3 μm (Fe/Mg).