THE TRANSMISSIVE CLAYS OF GANGES CHASMA: AN INVESTIGATION INTO SHARAD OBSERVATIONS ON A PHYLLOSILICATE RICH PLATEAU. C. A. Rezza[1] and I. B. Smith[1, 2], [1]York University, Toronto, Ontario (crezza19@yorku.ca), [2]Planetary Science Institute, Denver, Colorado.

Introduction: The plateau between Ganges and Capri Chasma in the eastern portion of Valles Marineris contains the widespread presence of Fe/Mg phyllosilicate clays [1], representing altered soils from Noachian terrain (Fig 1a). Understanding the nature of these deposits is vital to unraveling Mars' past and present climate. In particular, phyllosilicate deposits point to a history of water-rock interactions that may contain a record of habitability, the water cycle and variability, and geologic processes. In these clay-rich regions, we identify widespread reflections from the Shallow Radar (SHARAD) instrument that may provide clues to the emplacement and modification (Fig. 1b).

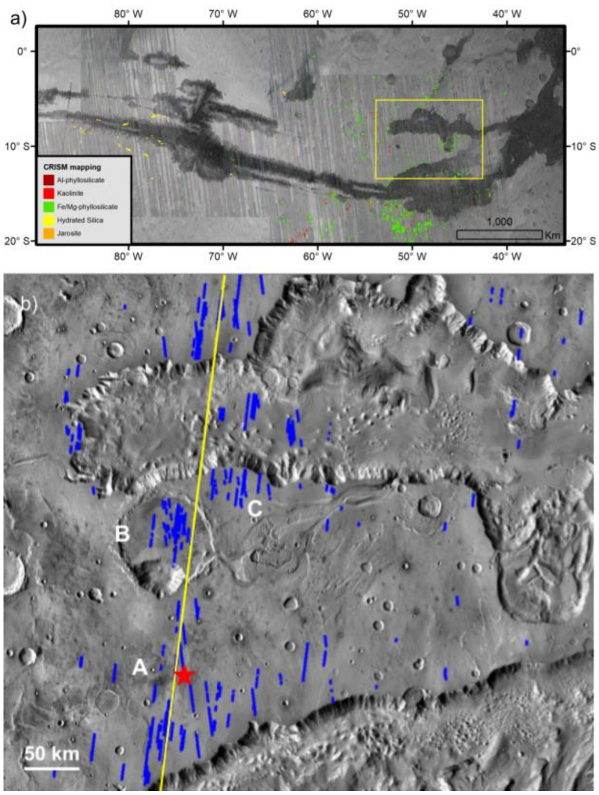

__Figure 1:__ Geologic Setting near Ganges Chasma a) A CRISM map of Valles Marineris, highlighting the detection of various, mostly Fe/Mg phyllosilicates. b) A map of Ganges Chasma showing detections of subsurface reflections by SHARAD (blue lines). A, B, and C denote the three regions of study. The yellow line represents the radar track in Fig. 2, and the red star represents the location of Fig. 3.

Orbital radar investigations of clays should not be possible. According to [2], radar waves should attenuate past the noise floor of the instrument on a very short scale due to high loss tangents. Despite this, SHARAD [3] analysis of the study region has identified basal reflections between ~220 and 307 ns below the surface (Figs. 1b, 2). We hypothesize that the penetration of radar signals through deposits one order of magnitude greater than anticipated has two possible origins: 1) the bound water content of the clays is much lower than previous work measured, or 2) the clays are very thin, and a second, deeper unit provides the subsurface reflections.

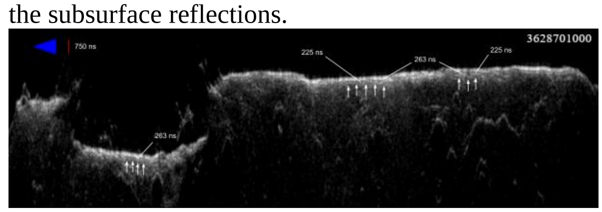

__Figure 2:__ Subsurface reflections in region A and B (Fig. 1b). The Blue arrow points north, and the red line represent the scale, which is approximately 56 m assuming a dielectric constant of 4. The radargram has been compared to clutter simulations to ensure that it is not clutter formed by off-nadir reflections or topography.

Geomorphic Analysis: In addition to the spectral signatures of clays and detection of subsurface reflections, these regions display light-toned deposits (LTDs) and polygonal fracturing (order 10 m) on the surface (Fig. 3) [4]. Shadow measurements of the polygons yields thicknesses of 1-5 m. Similarly sized polygons in sedimentary environments on Mars have been compared to terrestrial analogs identifying desiccation due to rapid water table retreat as a primary formation mechanism [5].

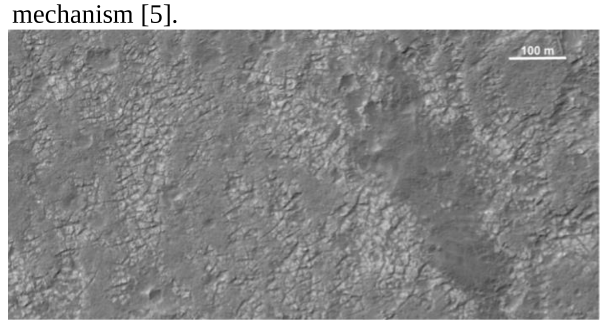

__Figure 3:__ Example of polygonal fractures located around region A (Star in Fig. 1b), The polygonal fractures are ~10 meters in dimension.

Further, there is evidence of a large flooding event originating from Morella crater (region B of figure 1), that may have flooded the basins of regions A and C [6], supplying the required water for chemical alteration. Later, the retreat of these flood waters may have resulted in desiccation of these phyllosilicates and the formation of the polygonal fractures. While the phyllosilicate detections in Figure 1a are not apparent over the whole basin, it is possible they have been buried by the polygonally fractured unit. If desiccation after the retreat of the flood waters took place, and such desiccation is sufficient to lower the loss tangent of the phyllosilicates, allowing deeper transmission and subsurface reflectors between ~220 and 307 ns, then this would verify hypothesis (1).

Laboratory Analysis: To test hypothesis (1) We are performing dielectric measurements on terrestrially derived materials of the same composition as the Fe/Mg phyllosilicates located around Ganges Chasma. To do this, we employ a Vector Network Analyzer (VNA) with a coaxial airline setup (Fig 4), following methodology from [7]. This test requires baking the samples to varying degrees in order to attain a trend of loss tangents (compared against mass loss of the sample after baking). With that we will be able to calculate the attenuation rate of the radar waves by the presence of these deposits [8], testing whether clays can be sufficiently dehydrated to permit radar wave propagation. To test hypothesis (2) we seek evidence of subsurface horizons that may correspond to a depth of ~20 m from the High Resolution Imaging Science Experiment (HiRISE) and the Context Camera (CTX). Identification of this horizon would permit us to measure the thickness of the unit and determine the attenuation rate, dielectric permittivity, and loss tangent of Martian materials.

The two hypotheses are not incompatible, so by performing the laboratory measurements and seeking evidence of a subsurface layer, we can test them both.

Preliminary Results: Two lab measurements using Ca-Montmorillonite (Stx-1b) are complete. The first was conducted on an un-baked sample for a control to measurements by [2]. We performed the second measurement after baking a sample that weighed 32.934g at 125° C for 24 hours. During baking, ~3.427g (10.6%) of the mass was lost, we interpret to desiccation. Both measurements have been corrected for their bulk densities per methods in [8].

In our measurements, the real part of the permittivity matches well with that of similar Fe/Mg phyllosilicates measured by [7]. We calculated the attenuation rate of the baked sample and found an attenuation rate of ~0.32 dB/m, larger than the maximum attenuation rate of 0.27 dB/m identified by [2].

Further tests with enhanced water loss will need to be conducted to see if the attenuation threshold of 0.259-0.274 dB/m for layers between 16-25 m thick can be surpassed through desiccation.

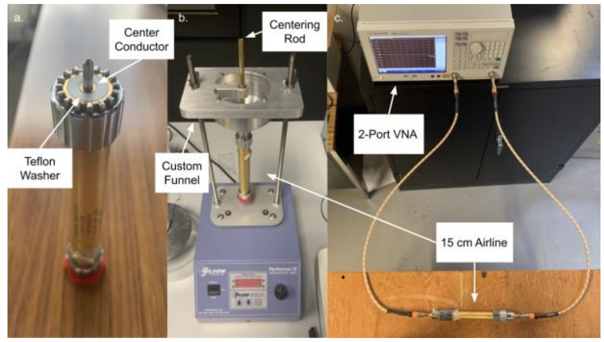

Figure 4: *The experimental setup for the dielectric laboratory measurements. a) The previously baked sample is packed into a 15 cm General Radio 900 coaxial airline around a center conductor. It is sealed in with a tight fitting Teflon washer. b) The sample is packed into the airline using a custom built funnel and a sieve shaker. The center conductor is held in place with a centering rod. c) After the sample is packed, it is attached to an Agilent E5071C two port VNA where microwaves are transmitted through the sample.*

Future Work: We continue our measurements with Stx-1b, baking it at increasingly high temperatures to have measurements with varying levels of moisture content. As mentioned, we continue searching for layer depths using HiRISE and CTX DTMs to compare with SHARAD measurements.

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References: [1] Le Deit, L. et al. (2012) *J. Geophys. Res.*, 117, E00J05. [2] Stillman D. E. et al. (2011) *J. Geophys. Res.*, 116, E03001. [3] Seu R. et al. (2007) *J. Geophys. Res. Planets*, 112, E05S05. [4] Le Deit L. et al. (2010) *Icarus.*, 208, 684-703. [5] El-Maarry M. R. et al. (2015) *J. Geophys. Res. Planets*, 120, 2241-2257. [6] Coleman N. M. et al. (2013) *J. Geophys. Res. Planets*, 118, 263-277. [7] Boivin A. L. et al. (2018) *J. Geophys. Res. Planets*, 123, 3088-3104. [8] Ulaby D. F. et al. (2014) *Ann Arbor MI: University of Michigan Press*.