PHYLLOSILICATE DEPOSITS IN SHALBATANA VALLIS Anne E. Wintzer[1], Carlton C. Allen[2], and Dorothy Z. Oehler[2]. [1]University of Arkansas (Center for Space and Planetary Sciences, 202 Old Museum Building, Fayetteville, Arkansas 72701, awintzer@uark.edu), [2]NASA Johnson Space Center, Astromaterials Research and Exploration Science (ARES) Directorate, 2101 NASA Parkway, Houston, TX 77058.

Introduction: Shalbatana Vallis is an ancient river valley on Mars, the westernmost of the southern Chryse outflow channels. The geologic history of this area has significant implications for understanding Mars' hydrologic and climate history. The highland flood basalts are cut by large collapse depressions, multiple outflow channels, and chaotic terrain. An intravalley paleolake with a depth of over 400 m, in the 125 km diameter Orson Welles crater (Fig. 1) and the adjacent section of Shalbatana Vallis, was deduced from Mars Orbiter Laser Altimeter (MOLA) topography, evidence of shorelines and the occurrence of fan-delta deposits, including Gilbert-style deltas [1].

A number of CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) images with strong phyllosilicate signatures have been identified throughout the channel and nearby highlands (Fig. 1). A majority of the signatures are concentrated in areas exposed by impact cratering. Since such minerals can form by a variety of different geological processes, such as weathering, burial diagenesis, and hydrothermal alteration [2], the nature of the phyllosilicate deposits in the Shalbatana Vallis region may provide insights into the formation processes that took place and help to place constraints on the early aqueous activity in the region.

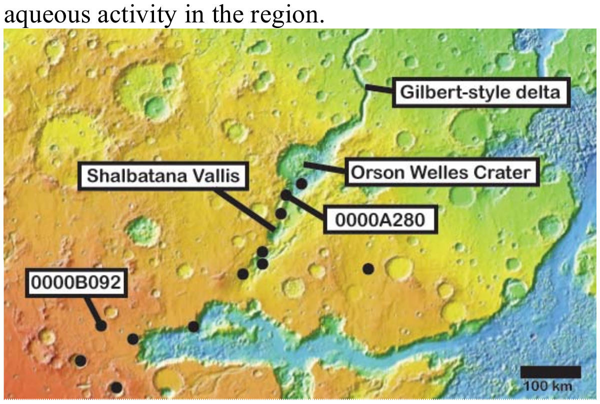

Figure 1. MOLA topographic map of Shalbatana Vallis; black dots indicate positions of CRISM images with strong phyllosilicate signatures. Spectra for the labeled CRISM images 0000B092 and 0000A280 are shown later.

We contribute to the understanding of the geologic history of Shalbatana Vallis using data from the HiRISE (High Resolution Imaging Science Experiment) and CTX (Context) cameras and the CRISM spectrometer on the MRO (Mars Reconnaissance Orbiter) spacecraft, and evaluating the mineralogy, origin, and placement of Fe/Mg-rich and Al-rich phyllosilicates in the region

Methods: Using the ir_phy browse products found on the CRISM website, http://crism.jhuapl.edu/, areas were selected within Shalbatana and the surrounding highlands that display strong phyllosilicate signatures, either red for Fe/Mg-rich compositions or green for Al-rich compositions. These images were then overlain on HiRISE images of the same location in order to choose the best areas to extract spectra and determine in higher resolution the correlated geologic features (Fig. 2). Using standard techniques, atmospheric correction was performed on the raw CRISM images using CAT (CRISM Analysis Tool) in conjunction with ENVI Image Processing software. Using IR wavelengths, eight spectra were extracted from 5x5 pixel spots in the corrected image that displayed high concentrations of phyllosilicates. These spectra were then ratioed to spectrally unremarkable spots of equal size in the same column in order to reduce column-dependent instrumental artifacts and to clarify mineral features. All eight ratio spectra were then averaged. The averaged ratio spectra were then compared to standard laboratory spectra from the CRISM Spectral Library. Topographic data from HiRISE were used to aid in regional stratigraphic correlations and improve our understanding of the three-dimensional geometries of the phyllosilicate-rich layers.

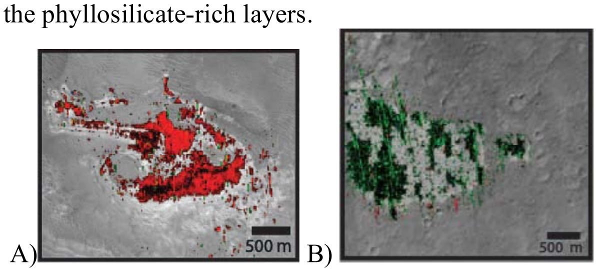

Figure 2. A) HiRISE PSP_007455_1785 shown with ir_phy overlay of CRISM 0000A280 B) HiRISE PSP_008800_1730 shown with ir_phy overlay of CRISM 0000B092.

Results: A majority of the phyllosilicate-rich areas sampled were dominated by Fe/Mg compositions. These were all observed within the rims of craters or the valley walls. The Fe/Mg phyllosilicates exhibited absorption bands near 1.45 µm, 1.9-1.95 µm, and 2.25-2.3 µm consistent with nontronite. The Fe/Mg-rich phyllosilicates were detected in continuous layers (Fig. 3) at altitudes ranging from 1939 m in the highlands to -1261m in the upper portion of the valley.

The Al-rich phyllosilicates were exposed in the highland plains, as well as near the deepest point in

Orson Welles crater. Those in the highland plains are located within shallow angular depressions (Fig. 2B). The Al-rich phyllosilicates exhibit bands near 1.5 µm that are consistent with prehnite, as well as bands at 1.44 µm and 2.21 µm consistent with kaolinite and montmorillonite (Fig. 4). These exposures are most likely mixtures of several Al-rich clays. These findings are consistent with mineral compositions found previously by Carter *et al.* [2] in the northern plains.

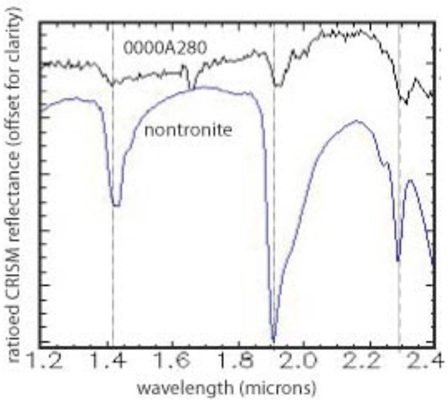

Figure 3. Ratioed spectrum of CRISM 0000A2880 compared with laboratory spectrum for nontronite; band at 1.66 µm is instrument artifact.

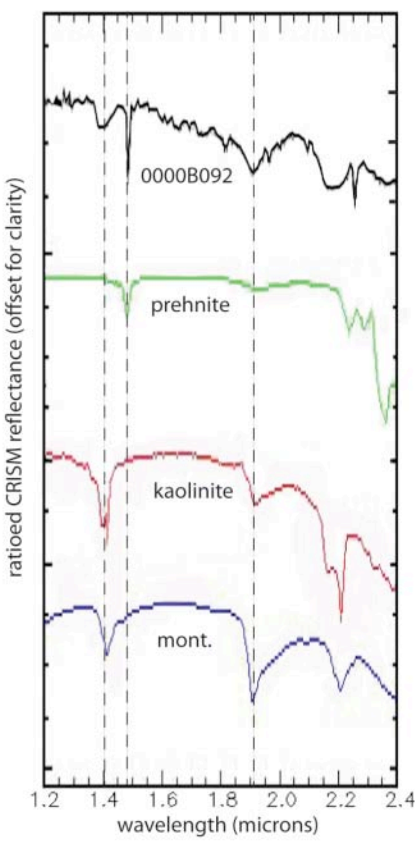

Figure 4. Ratioed spectrum of CRISM 0000B092 compared with laboratory spectra of prehnite, kaolinite, and montmorillonite.

Discussion: All exposures of Fe/Mg-rich phyllosilicates are distinctly layered (Fig. 2A) and occur at various altitudes throughout the highlands and channel area, analogous to multiple phyllosilicate-rich interbeds within layers of flood basalts. Nontronites are also typical alteration products of basalts [3] and current data are not sufficient to differentiate between a detrital and an authigenic origin. No Fe/Mg-rich signatures were found in the valley north of Orson Welles crater, nor in the adjacent Chryse lowlands, indicating that any depositional sink was either not visible due to dust covering, was removed by erosion, or is in a location not yet covered by CRISM.

There are fewer examples of Al-rich phyllosilicates in the region, and the signatures are found in both the highlands and deep within Orson Welles crater. These phyllosilicates could either be products of aqueous alteration and leaching of Fe and Mg from the highland rocks or alteration of a later Si-rich volcanic ash or sediment [4]. The Al-rich phyllosilicates within the highlands appear to be remnants of a continuous stratigraphic layer and possible source deposit for the Al-rich phyllosilicates seen at a lower elevation within Orson Welles crater. The angular shape of the depressions containing the Al-rich deposits in the highlands (Fig. 4) may also be an erosional feature related to the desiccated texture seen on the surface. The Al-rich phyllosilicates within the basin of Orson Welles are scattered and display no clear layering. This would suggest that these are sediments transported during a flood event or deposited in the crater lake. This is the only location within the study area where geologic relationships favor detrital phyllosilicates. The mineral signatures of these phyllosilicates are consistent with those presented in *Carter et al.* [2], suggesting similar starting materials and alteration processes as phyllosilicates sampled in the Northern Plains.

Future Work: Continued spectral analysis of phyllosilicates is needed to correlate continuous layers of sediment across the region. The area north into Chryse and Acidalia also needs to be studied further to determine if there are identifiable sinks for the phyllosilicates. There are limited CRISM data in the area, so as more image data are collected, further interpretation will be possible.

Acknowledgements: I would like to thank the Lunar and Planetary Institute and the JSC ARES Directorate for this opportunity and their support.

References: [1] Di Achille, G. *et al*. (2009*) Geophys. Res. Lett*., **36**, L14201, doi:10.1029/2009GL038854. [2] Carter, J. *et al.* (2010) *Science, 328,* 1682-1686. [3] Velde, B., ed. (1995) *Origin and Mineralogy of Clays*, Springer-Verlag. [4] Bishop J. L. et al. (2008) *Science, 321*, 830-833.