ONGOING CRISM INVESTIGATION OF RIDGE NETWORKS AND THEIR PHYLLLOSILICATE-BEARING HOST UNIT IN THE NILI FOSSAE AND NORTHEAST SYRTIS REGIONS. A. C. Pascazzo\textsuperscript{1} and J. F. Mustard\textsuperscript{1, 2} \textsuperscript{1}Department of Earth, Environmental and Planetary Sciences, Brown University, RI, 02912 USA (alyssa_pascuzzo@brown.edu)

\textbf{Introduction:} Large scale, curvilinear and polygonal ridge networks are readily observed in the greater Nili-regions [1-6], however their origin is unresolved. High-resolution images show ridges exposed along scarp walls, crater floors, and through erosional windows [2]. Extensive mapping and morphologic characterization of ridges across Nilsyrtis Highlands, Nil Fossae, and NE Syrtis have shed light on the diversity of length and orientation among ridges in these regions [1-3]. The morphology of the ridges suggests that surface processes (i.e., aeolian and glacial sedimentary deposition) are unlikely candidates for their formation [2]. Possible subsurface ridge formation mechanisms include: 1) volcanic dike intrusions, 2) breccia dikes from impact cratering, 3) clastic sedimentary dikes from pressurized fluid injection, and 4) precipitation of minerals in pre-existing fractures [e.g., 3, 7-9]. Exposed ridges are commonly hosted in Fe/Mg-phylllosilicate bearing rocks throughout Nili Fossae and portions of NE Syrtis [4, 5, 10]. Determining the ridge composition would provide important data to assess mechanisms for formation. However, the ridges are at the limit of CRISM’s spatial resolution. Here, we use careful mapping with HiRISE and CRISM spectral ratios to isolate the spectral characteristics of the ridges from the host unit in order to evaluate the hypothesized mechanisms responsible for ridge formation in the greater Nili-regions.

\textbf{Regional stratigraphy:} In areas where dust is minimal, Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), Observatoire pour l’Minéralogie, l’Eau, les Glaces, et l’Activité (OMEGA) and High Resolution Imaging Science Experiment (HiRISE) imagery show ridges being exhumed from a Fe/Mg-phylllosilicate bearing host unit [4, 5, 10]. In the Nili Fossae and NE Syrtis regions, ridges have been exhumed exclusively from the clay-bearing unit. A spectrally “bland” olivine-bearing mafic capping unit lies stratigraphically above the clay-bearing ridge-hosting unit. The ridges have never been observed in the mafic capping unit [4, 5].

\textbf{Methods: Data Selection & Processing.} We identified 10 CRISM observations containing ridges across the areal extent of mapped ridges [1, 2], that had both minimal dust coverage and overlapping HiRISE imagery, from which spectra were collected. Both S and L detector data were used from each observation for VIS and NIR wavelength coverage (0.4–2.6 μm). The CRISM data cube pairs were atmospherically corrected using empirically derived volcano scans optimized for each observation utilizing the CRISM Analyses Tool in ENVI/IDL. CRISM detector pairs were then map projected and layer stacked for the full wavelength range.

\textbf{Regions of interest (ROI) selection.} Both CRISM and HiRISE use the same equatorial projection and Mars Orbiter Laser Altimeter-derived planetocentric coordinate system, however, warping and misregistration between the datasets are present. This is due to HiRISE taking along-track observations versus CRISM’s gimbaled observations over rugged terrain [11]. The latter, in tandem with ~1:1 CRISM pixel-to-ridge width (Fig. 1), presented some difficulties in selecting representative ridge pixels. As a solution, the full resolution HiRISE image for each scene was spatially resampled to the corresponding CRISM image spatial resolution using pixel aggregation. The original HiRISE image was then geographically linked to the resampled image, which allowed for visual accuracy and selection of ridge pixels in the CRISM data (using the 700nm band) in reference to location and relative pixel brightness (Fig. 2).

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure1.png}
\caption{Example of CRISM pixel-to-ridge crest width.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure2.png}
\caption{(a) full resolution HiRISE 0.25 m/pixel (b) pixel – ridge matching using resampled HiRISE (18m/pixel) and full resolution HiRISE (c) pixel-ridge matching using CRISM (700 nm band, 18 m/pixel) and full resolution HiRISE image. (CRISM: FRT00008711C, HiRISE: PSP_002176_2025)}
\end{figure}
Host unit ROIs were collected in two groupings pertaining to the most common rock textures: 1) smooth and 2) fractured or layered breccia blocks (Fig. 3). Sand dunes were avoided and distance between ridge ROIs and host unit ROIs was maintained to avoid incorporating spectra from darker toned, loose material accumulated around the base of ridges (Fig. 3a).

**Ridge morphology:** The majority of the ridges observed in this study are exposed as polygonal networks and isolated ridge clusters that are on average < 500 m in length and < 20 m in width, many of which contain knobs/mounds along their length, particularly at ridge intersections [1, 2]. HiRISE Digital Elevation Models (DEM) of the ridges show that their widths taper with height into a rounded crest opposed to a flat top, revealing recently exposed ridge material relative to the slopes of the ridges. The slopes consist of host rock material and ridge talus (Fig. 3c). The ridges erode into boulders, which is most notable at ridge intersections and knobs (Fig. 1).

**Spectral Observations:** The host unit and ridges share distinct H2O and Fe/Mg-OH absorption minima indicative of Fe/Mg-phyllosilicates at 1.42, 1.91, and 2.31 µm (Fig. 4). While band position does not change between the ridges and its host unit, the ridges show comparatively weak absorptions. The absorption strength difference between ridge and host is most prominent at the 1.91 and 2.31 µm regions. In addition, the difference in absorption strength is greater relative to the fractured host unit than the smooth host unit spectra (Fig. 4). This implies that the ridges more closely resemble the smooth host unit, spectrally, than they do the fractured host unit. The fractured host unit may be better exposed bedrock compared to the smooth host unit.

**Discussion and ongoing work:** Larger particle size, lower albedo, and steep continuum slopes may cause absorption weakness unrelated to mineralogy. Continuum slope and small albedo changes can be corrected with continuum removal and conversion of CRISM I/F reflectance to single-scattering albedo (SSA), under Hapke assumptions [12], which will be a target for our continued investigation. Albedo and slope effects aside, our results thus far suggest that compositional differences, dust coatings, or larger particle sizes are possible causes for the 1.91 and 2.31 µm absorption weakness. Compositional factors that may cause weaker water and metal-OH absorptions include: 1) dehydration of hydrous minerals, 2) less alteration of primary minerals, 3) hydrated silica, or 4) impact/volcanic glass.

Future work will focus on rigorous evaluation of hypotheses for reduced band depth. Furthermore, we are pursuing quantitative geomorphic analyses of ridges, in addition to spectral analyses in order to shed light on the origin of these enigmatic ridges.