USING SERPENTINE AS A MINERAL TRACER FOR HABITABLE ENVIRONMENTS ON MARS.

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Introduction: Martian locales that show evidence for serpentinization are some of the most compelling sites to study from a habitability perspective. Serpentinization reactions imply liquid water at relatively low temperatures, a source of bioaccesible H_2, and can result in the production of low-order ogranics like CH_4 [e.g., 1]. Previous studies of serpentine on Mars show limited detections across the southern highlands [2-3], particularly concentrated in the Nili Fossae region in association with olivine-rich basalt. This study aimed to understand the global distribution of minerals associated with serpentinization, like those found in Nili Fossae [4] and their relationship, if any, to other ultramafic regions on Mars. This distribution would provide a better understanding of the regions on Mars that once had the highest potential for habitability.

Methods: We performed a comprehensive analysis of the entire CRISM spectral dataset. Given the magnitude of images (>13,000) and the subtle/weak spectral features associated with serpentine, we used factor analysis and target transformation methods to efficiently parse through the available CRISM data [e.g., 5]. These methods not only allow for the timely analysis of thousands of images, but provide a quantitative means to determine the significant spectral constituents of an image, even if they are only present at low concentrations.

Results: The methods used were successful in corroborating previous detections of serpentine using traditional CRISM analysis techniques, and found additional detections across the martian southern highlands (**Fig. 1**). Serpentine detections were not particularly associated with ultramafic regions or with other mineral phases investigated (Mg-carbonate and talc/saponite), other than in Nili Fossae. Most serpentine detections were found in isolated exposures, associated with crater ejecta, knobby terrain, or as part of discontinuous layers in crater or valley walls. Some serpentine detections were found within a more complicated geologic or mineralogical context, such as in Claritas Rise, in Mawrth Vallis, and in Nili Fossae. Overall, the detection of serpentine from orbit were still quite rare, though detections were found dispersed across the southern highlands. Nili Fossae showed more pervasive and extensive detections of serpentine than previously thought, particularly in the eastern portion of Nili Fossae where the highest concentration of olivine-rich basalts is located.

Implications: These findings imply that large, regional-scale near surface serpentinizing systems were likely rare on Mars, at least as observable today. Low-concentration serpentine detections across the southern highlands do however point to a global serpentinization system, likely early in Mars history when the planet was more geologically active. Nili Fossae appears to be unique amongst other olivine-enriched regions, potentially due to its proximity to the nearby Syrtis Major volcanic province. Northeast Nili Fossae shows the strongest evidence for a sustained, low-temperature serpentinizing system in its history, and is a compelling site for further study with respect to astrobiology.

References: [1] Kelley D. et al., (2001) *Nature, 42,* 145-149. [2] Ehlmann B. et al., (2010) *GRL, 37,* L06201. [3] Viviano-Beck et al., (2017) *Icarus,* 284, 43-58. [4] Amador E. et al., (2013) *LPSC 44,* #2742. [5] Thomas N. et al., (2014) LPSC 45, #1909.

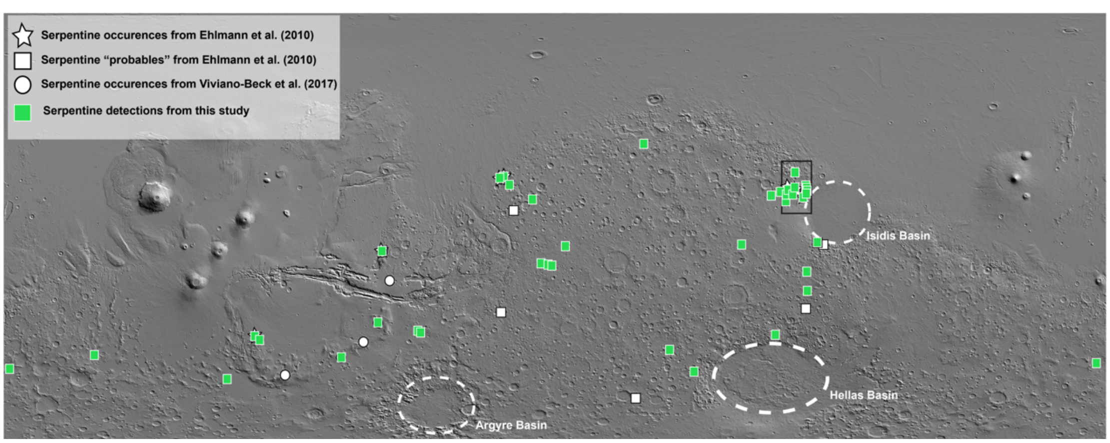

Figure 1. Distribution of serpentine detections using factor analysis and target transformation of CRISM spectral data compared to detections from previous studies. Highest concentration of serpentine detections are found within the Nili Fossae region (black inset box)