EXPLORING THE LINK BETWEEN CRYPTIC AND NON-CRYPTIC ARANEIFORM CLUSTERS AND ENVIRONMENTAL FACTORS ON THE MARTIAN SOUTH POLE. J. Venkatraman[1] (j.venkatraman@ucla.edu), C. Quiñones-Martínez[2], L. E. Mc Keown[3], S. Diniega[3], C. J. Hansen[4], G. Portyankina[5], S. Piqueux[3], and K.-M. Aye[6]. [1]University of California, Los Angeles, CA, USA, [2]University of Puerto Rico, San Juan, MX, [3]Jet Propulsion Laboratory, Pasadena, CA, USA, [4]Planetary Science Institute, AZ, USA, [5]German Aerospace Center DLR, Berlin, Germany, [6]Free University of Berlin, Berlin, Germany.

Introduction: Araneiforms, colloquially termed 'spiders', are a distinctive class of Martian sublimation features that have no known Earth analogs [1,2,3]. They are negative topography features characterized by a central depression with radially emerging dendritic troughs. Their long axis can extend beyond 1 km and they have various morphologies [1,3]. Often occurring in clusters [11,12], spiders are thought to form to their current extent over time and as a result of the extension and recession of seasonal CO_2 ice overlying the South Polar Layered Deposit (SPLD) cryptic region [5,13]. According to the Kieffer Model, an increase in spring-time solar insolation triggers basal sublimation of CO_2 ice, subsequent high pressure gas buildup, and ice failure, lofting up substrate in an ice- and dust-rich plume that gradually erodes troughs over thousands of Mars Years (MY) [4,5,7]. However, these hypotheses remain debatable due to a lack of ground truth observations and field analogs. In particular, the spatial distribution of spiders within and beyond the SPLD has not been fully mapped and there are no observation-based constraints on the timescale of spider formation and growth. Despite multiple observational campaigns over the last 6 MY, although plumes have been observed to disappear and reappear, no spiders have been observed to actively form or grow on the SPLD [4,6].

Within the SPLD, spiders have been found to preferentially form in cryptic terrain that exhibits unique CO_2 frost conditions [5]. Here, we investigate the differences between spiders in the cryptic and non-cryptic regions of the SPLD to further understand the conditions associated with their formation with the contiguous Murray Lab CTX Global Mosaic Map. To do so, we expanded the published catalog of spiders [1,6,7] to quantitatively compare spider distributions in the cryptic and non-cryptic terrains, and investigate potential environmental factors contributing to spider formation.

Methods: We used cryptic layers from Piqueux et al. (2003), where they located the boundary of the cryptic region using the Thermal Emission Spectrometer (TES) data. For each L_s interval, only regions (1) with an albedo less than 0.38 and (2) within the seasonal cap were considered cryptic terrain [8]. Since the cryptic area changes as we progress through the Martian seasons, we mapped Spiders through inspection of The Context Camera (CTX) Global Mosaic (v01 from the Murray Lab viewed in JMARS) which provides global coverage of 99.5% of the Martian surface from 88S to 88N rendered at 5m/px [9]. When needed and available, High Resolution Imaging Experiment (HiRISE) stamps were used for investigation at sub-meter resolution. We focused on one cryptic and one non-cryptic latitudinal transect from the pole to -65°N, spanning 160-190E longitude and 280-310E longitude, respectively. We mapped spiders at 8192 pixels per degree (ppd) resolution. No other geologic, slope, or temperature maps were used to create our map.

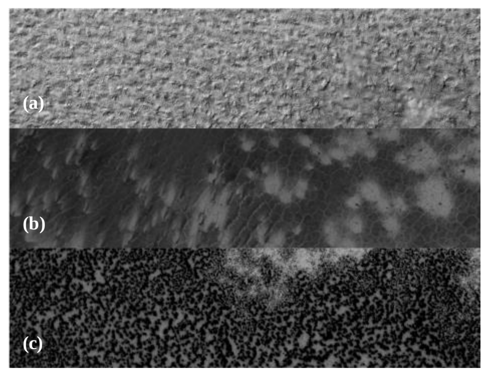

Fig. 1: Our Araneiform classification scheme showing (a) distinct araneiforms, (b) lace/polygons, and (c) maybe lace/polygons.

Classification scheme: Within our selected transects we identified two classes of spiders: distinct araneiforms and lace terrain [4,13]. Distinct araneiforms are characterized by troughs separated from one another (*fig. 1a*), while lace terrain has dense, connected networks of anastomosing troughs (*fig. 1b,c)*. Features with uncertainty (e.g. only dark fans were visible but there was strong potential for troughs under the frost identified by faint but indiscernible troughs: *fig. 1c*) were classified as 'maybe spiders' or 'maybe lace/polygons'. Lace and polygonal terrain were grouped as they are often indistinguishable.

Results: Our mapping of spiders and lace are shown in *fig. 3*. The spiders and lace terrain in the cryptic region cover far more area than those in the non-cryptic terrain (*fig. 2*): the non-cryptic spiders and lace cover a total of ~3600 sq km, while those in the cryptic cover ~39,000 sq km. These results make sense within the context of the Kieffer model as the greater the ice translucency, the more likely it is for underlying substrate to heat the ice above it, creating the plumes that lead to the formation of spiders. Spiders and lace also tend to cluster quite a bit more in the cryptic terrain as opposed to the non-cryptic. In other words, our mapped shapefiles cover more contiguous regions in the cryptic than in the non-cryptic. This may suggest that cryptic spiders formed contemporaneously under a past climate with more favorable conditions.

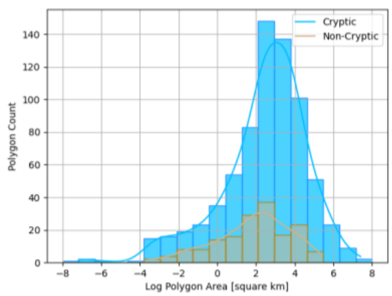

Fig. 2: Histogram of area in square km covered by our mapped spider and lace polygons in cryptic and non-cryptic terrain.

Using the geologic maps from Tanaka and Scott (1987), we compared our spider distribution to the nature of underlying substrate (*fig. 3*). In the cryptic region the spiders follow closely the contours of the SPLD. This is consistent with many previous studies that report the same findings. A few spider clusters form outside the SPLD on buried crater ejecta unit *Icm1* in dark brown, and the highlands cratered unit *Npl1* in tan. *Npl1* is heavily cratered and contains a lot of impact breccias. Schwamb et al. (2019) reported 96 spider detections that were outside the SPLD, including on possible ejecta blankets. In both these cases the likely hypothesis is that crater ejecta blankets are easily eroded and thus slab ice would not need to be present for as long, or be as thick, as on the SPLD for spiders to form. In the non-cryptic region, spiders and lace do not form on the permanent cap. This is also consistent with previous studies, and the absence of spiders in this region is generally understood as a consequence of the cap's high albedo and high degree of competence, making them absorb less solar radiation, and be less susceptible to scouring.

In combination with previous work [1,6], this work results in the most contiguous map of spiders till date. With this expansion in coverage, we will be able to draw more conclusions about geologic context and paleoclimate of spider formation in cryptic and non-cryptic terrains on the Martian SPLD.

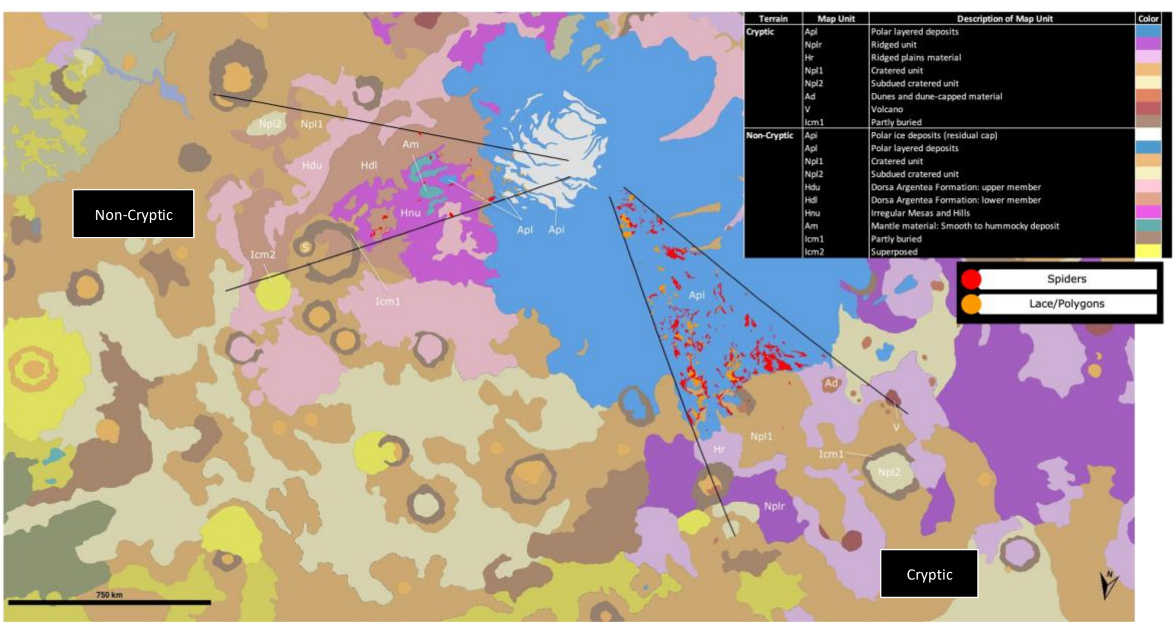

Fig. 3: Our map of spiders and lace overlayed on a geologic map of the polar regions of Mars [10]. The S pole is at the intersection of the latitudinal transects.

References: [1] S. Piqueux et al. (2003) *JGR: Planets,* 108 (E8). [2] H. H. Keiffer (2007) *JGR* 112. [3] S. Diniega et al. (2021) *Geomorph* 380. [4] C. J. Hansen et al. (2010) *Icarus* 205: 283-295. [5] H. H. Kieffer et al. (2006) *Nature Letters* 442. [6] M. E. Schwamb et al. (2018) *Icarus* 308: 148-187. [7] L. E. Mc Keown et al. (2021) *Nature Scientific Reports*. [8] S. Piqueux et al. (2003) *JGR: Planets* 108 (E8). [9] J. L. Dickson et al. (2023) *LPSC LIV*. [10] K. L. Tanaka et al. (1987) *USGS*. [11] L. E. Mc Keown et al. (2023) *EPSL*. [12] J. Hao et al. (2020) *Planetary and Space Science 185*. [13] G. Portyankina et al. (2017) *Icarus 282(15)*. [14] L. E. Mc Keown et al. (2022) *AGU Fall Meeting 2022.*