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Investigation of regional settings for formation of Araneiform Terrain, Mars

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1. Introduction

Seasonal variations of solar insolation cause sublimation/condensation cycle of CO_2 ice annually. This seasonal behaviour creates an impermeable and translucent CO_2 ice which lay partly in the south polar area every winter [1]. In the spring, sunlight penetrates the ice layer directly heating the substrate which causes basal sublimation. The sublimating gas is trapped inside the substrate [2] or between the substrate and the ice layer [1, 3-4]. With pressure building up, the overlying translucent ice layer finally ruptures, entraining dust and sand from the inside of substrate into the atmosphere causing sculpture into the ground [1-4]. This is proposed to be essential formation mechanism for araneiform terrain (dubbed "spider") which is characterised by radial-organized or dendritic troughs (Fig.1) exclusively observed in south polar area.

Spiders had long been reported as distributed only in the south polar layer deposits (SPLD) [3]. This has been interpreted that SPLD not only has seasonal translucent CO_2 ice slab, but also hosts unconsolidated upper surface with high erodibility [3]. However, recent research [5] reported the observation of spiders outside the SPLD [5]. This raises some new questions as follow:

What are similarities and differences of regional settings between SPLD and these new spider host locations (e.g., substrate properties)? Do the spatial settings of spiders have regional characteristics? How and to what extent are they indicative of regional or local substrate properties?

Thus, in order to answer these questions, it is necessary for us to conduct an investigation of regional settings for spiders. Hence, we chose areas from all known spider hosting regions with HiRISE observations to measure their spatial randomness and investigate their regional settings and analyse their correlations. Our work can improve the understanding of spider formation mechanism and provide insight into the polar surface processes.

2. Background

Our research [2] suggests that the sublimating gas is trapped inside the substrate and consequent gas jetting activities originate from the inside of the substrate. Thus, the substrate properties (i.e., porosity and degree of cohesion) are crucial parameters for spider formation. On account of mutual influence of neighbouring spider extremities to pressure accumulation and gas-jetting efficiencies, we can expect that in the vicinity of one spider, initiations of new spiders are inhibited, indicating the existence of an inhibited zone [2]. The spatial randomness analysis results of one sample spider population indicate that spider spatial distribution is non-random, which is consistent with the above suggestion for spider formation mechanism [2]. This analysis yields a value (the mean 2nd-closest neighbour distance, hereafter "M2CND") not only corresponding to average spacings but also indicating the minimal size of inhibited zones in one spider population [2][6]. One could expect that this value is indicative of regional substrate properties and varies from region to region. These are our suggestions for scenarios of araneiform (spider) formation and its distribution characteristics (for more details see [2]).

3. Results and discussions

The spatial randomness analysis can measure average spacing for one spider population (Details see [2][6]). Here we chose eight regions from all of the reported area where spider have been observed. Since HiRISE's high spatial resolution [7] can substantially improve the accuracy to map spider spatial distribution and identify its morphologies, only regions which have available HiRISE images were chosen.

We conducted spatial randomness analysis for each region (Fig.2), and results show that spider distributions in these regions are non-random. We classified these M2CND values into three types (Table 1) according to their orders of magnitude. These values show a link with the latitudes of the host regions (Fig.1). In the poles, increase in the latitude will receive a considerably increased amount of solar energy. For example, the latitude of around 86° (region A, B, C and D) receives around 2.5 times more solar energy than that of around 81° (region In1, In2 and F). Thus, we suggest significant differences of average spacings among 3 Types can be partly attributed to Latitude differences.

Generally, regions of the larger spacings have higher elevations (Fig.1) except region E. This is likely because the major host of spiders, SPLD, is located on the southern plateau (Fig.1). Another possibility is that elevation distributions also essentially coincide with geological units.

Table 1. The three types of spider distribution regions

Type	Region	M2CND (m)
Type1	A	195
	B	197
	C	220
	D	273
Type2	E	417
Type3	F	76
	In1	55
	In2	62

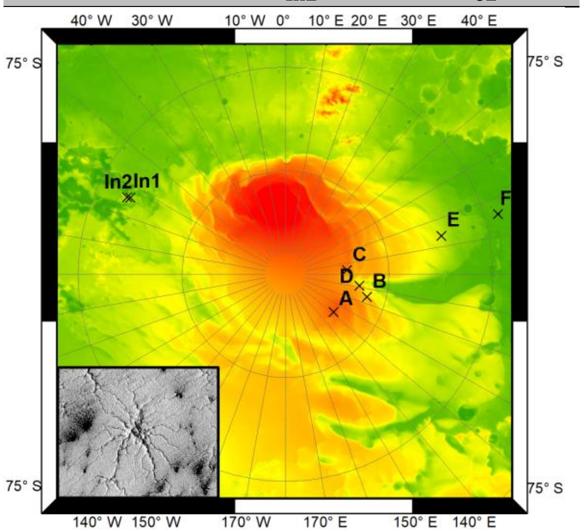

Figure 1. Eight regions which host spiders chosen in this work. They are indicated by black cross shapes. The color ramping map is MOLA DEM with 100m/pix (provided by Sebastian Walter). The inset image HiRISE PSP_003928_0815 shows an example of spider morphologies. The intervals in latitude and longitude are 5º and 10º respectively.

4. Conclusions and future work

The preliminary results we present here indicate spatial formation of spiders is influenced by the regional settings. Non-random spatial distributions in different regions lend more support to our suggestion for spider formation mentioned above [2]. With acquisition of more accurate data in the future, we expect to take other regional parameters (e.g., porosity, degree of cohesion, albedo, thermal inertial, soil water ice content, particle size, local topography) into consideration to perform more comprehensive investigations on influences of regional parameters on spatial settings of spiders.

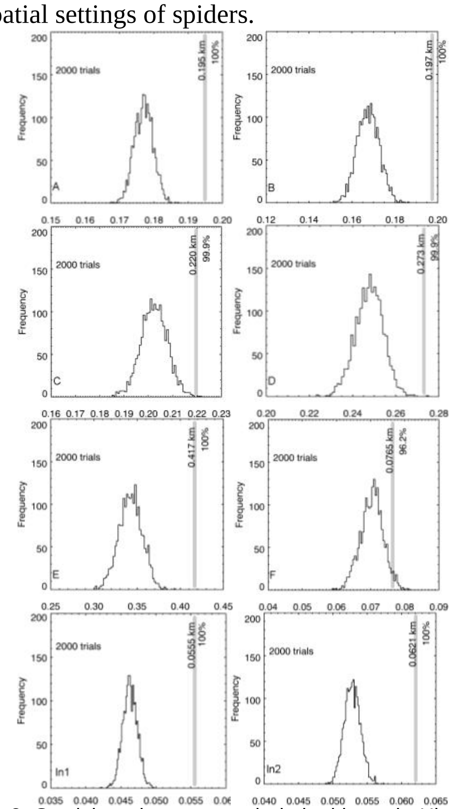

Figure 2. Spatial randomness analysis in this work. Histograms showing M2CNDs for 2000 random configurations relative to the M2CND values (grey bar) of observed spider populations [2][6]. If the measured M2CND is larger than the majority of random configurations, it shows that the spatial distribution is 'more separated than random' or non-random. All of these eight regions exhibit non-random spatial distributions of spiders.

References

[1] Kieffer et al. (2007) Nature 442, 793-796. [2] Hao et al., Icarus, under revision. [3] Piqueux et al. (2003) JGR, 108 (E8), 5084. [4] Hansen et al. (2010) Icarus 205(1), 283-295. [5] Schwamb et al. (2017) Icarus, 308, 148-187. [7] McEwen et al. (2007a) JGR, 112, E05S02. [6] Michael et al. (2012) Icarus 218, 169–177.