DUNE MORPHOLOGY AND ITS EFFECTS ON THE THERMAL BEHAVIOR OF OLYMPIA UNDAE.

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Synopsis: We analyzed the morphologic patterns seen in Olympia Undae, Mars' largest dune field, and assessed their effect on the thermal behavior of the region. In this work, we measured crestline orientations and the percent coverage of interdune areas with higher albedo materials. Crestline orientations matched those published previously [1]. Our analysis of the inter-dune areas shows that these areas cover only a small portion of the field (2–8% of total area).

Background: The north polar layered deposits are surrounded by dunes known as the circum-polar erg, which includes the vast dune field called Olympia Undae. These dunes exhibit values of thermal inertia of ~75 tiu (J m^{-2} K^{-1} $s^{-1/2}$), significantly lower than that of similar dunes at lower latitudes which have values (~250 tiu) more consistent with sand-sized basaltic grains. Although exotic materials have sometimes been invoked for the erg, recent work has shown that basaltic sand overlying ground ice could explain the anomalous thermal inertia [2]. However, this layered model did not include slope effects, of potential importance in a dune field where a regular pattern of opposing slopes is prevalent. To evaluate the impact of slope, we used HiRISE images to quantify the dune morphology, including measurements of crestline orientation and the areal coverage of light-toned inter-dune deposits. We then use this data to calculate the apparent thermal inertia expected from such a mixture of sloped and tonally contrasted surfaces.

Crestline Orientation: A regular pattern of dune forms characterizes the dune fields of Olympia Undae. Primary and secondary sets of dunes exist whose crestlines are nearly orthogonal, forming a rectilinear pattern. The crestlines of the primary dunes are longer and more widely spaced compared to those of the secondary dunes. The crestlines of the secondary dunes form between the primary crestlines, and often line up end to end across the primary crestlines.

To catalog the crestline orientations, a sample of seven dune fields within Olympia Undae and two dune fields outside of Olympia Undae were analyzed (Fig 1). The primary and secondary crestlines were digitized from each dune field's HiRISE image (Fig 2).

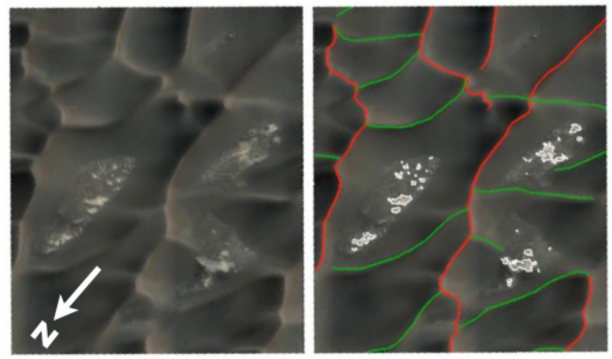

Figure 2. A. Section of HiRISE image PSP_001432_2610 B. With digitized primary and secondary crestlines and outlined light interdune areas.

Directional analysis was performed on the resulting vector data to determine the average crestline orientation (Fig. 3). The calculated crestline orientation for one particular study area, captured in HiRISE image PSP_001432_2610, closely matched the results of other studies [2].

Interdune Areas: The interdune areas are apparently flat, and in patches appears bright due to a higher albedo measurement. These bright patches can be easily seen in the HiRISE images of the dune fields. Other researchers have determined that these patches are possibly surface deposits of water ice or thin layers of bright dust [3]. We analyzed the HiRISE images to determine what percent area these bright patches covered, using GIS software to identify the bright patches and compute their area relative to the entire image

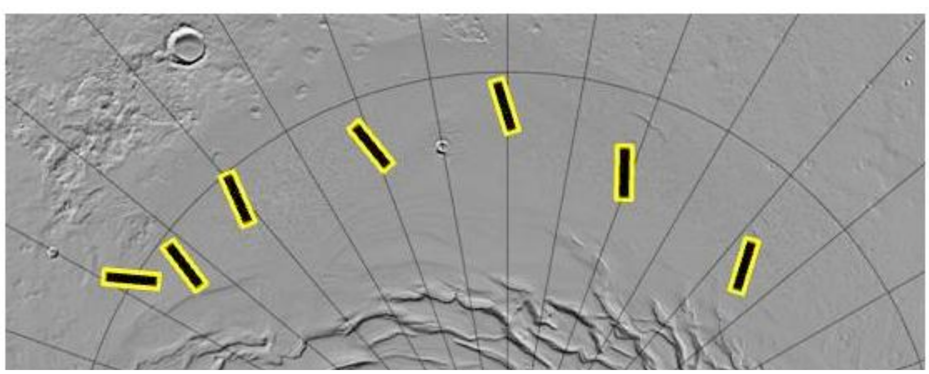

Figure 1. Location of HiRISE images within the Olympia Undae Dune Field.

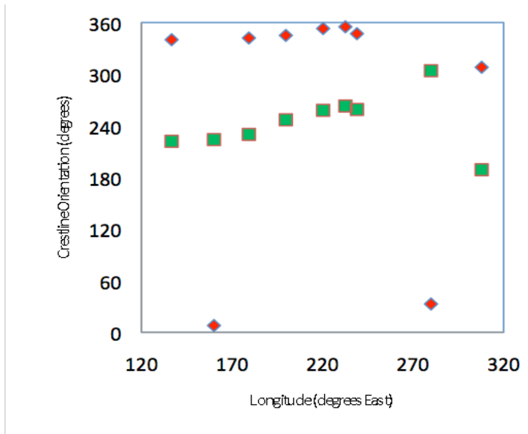

Figure 3. Crestline orientation (degrees east of north) as a function of longitude within Olympia Undae. Green boxes are primary crestlines and red diamonds are secondary crestlines.

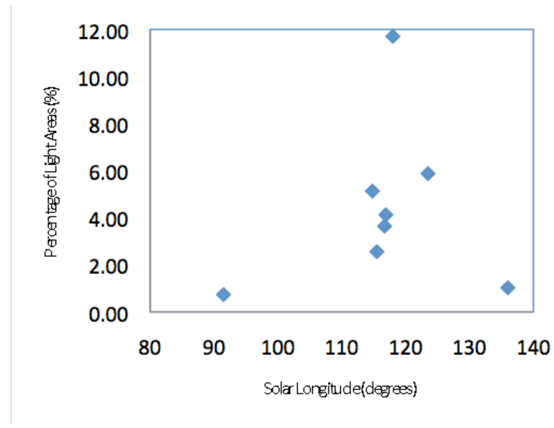

Figure 4. Percentage of area covered by light-toned inter-dune materials within the study area.

(Fig. 2). The results indicate that these bright patches make up a small portion of the total area of the dune field, covering 2–8% of the total area (Fig. 4).

Thermal effects of slope: We employed a thermal model used in previous studies [2 and references therein] to calculate the apparent thermal inertia that might be expected from the dune field, assuming a constant half-space of sandy material (I=225 tiu; black dashed lines in Fig. 5). The model surface consisted of (1) 40% by area of a surface sloped 3 degrees at an azimuth of 250 degrees east of north, (2) 40% by area of a surface sloped 2 degrees at an azimuth of 70 degrees east of north, and (3) 20% by area of a surface with no slope. This model surface represents the primary crestlines as measured from the HiRISE images. Our result for this model show that the effect of these slopes on the apparent thermal inertia of the dunes is minimal (see Fig. 5). Further work is needed to incorporate the inter-dune albedo effects, but our preliminary conclusion is that the observed behavior in apparent thermal inertia is predominantly due to layering, with slope and albedo effects being much less important.

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References: [1] Ewing, R.C. et. al (2010) *Journal of Geophysical Research, 115, E08005*. [2] Putzig, N.E. et. al (2010) Second International Planetary Dunes Workshop: Planetary Analogs—Integrating Models, Remote Sensing, and Field Data, LPI Cont. No. 2037. Lunar and Planetary Institute, Hourston, TX. [3] Feldman, W.C. et al. (2007) *Icarus, 196,* 422-432.

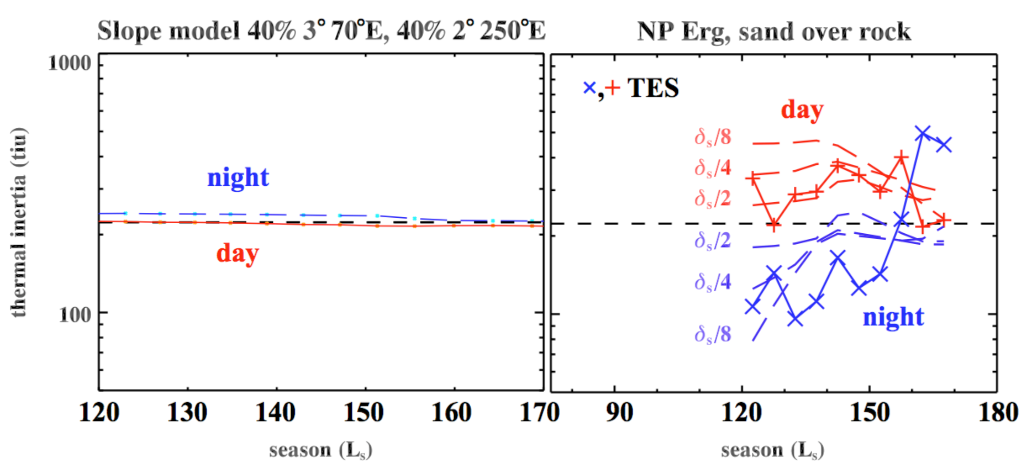

Figure 5. Apparent thermal inertia of Mars. Plot on left shows result for a mixed-slope model representative of the Olympia Undae region. Plot on right (from [2]) shows observed TES 2AM and 2PM apparent thermal inertia and results for a layered model containing various thicknesses of sand overlying "rock" (or equivalently ice-cemented sand).