ORIENTATION AND SPACING OF SMALL-SCALE SURFACE FEATURES IN MARS' NORTH POLAR CAP: PRELIMINARY RESULTS. T. Giang Nguyen[1]. John E. Moores[1]. [1]Center for Research in Earth and Space Science, Department of Earth and Space Science, York University, 4700 Keele Street, Toronto, ON M3J 1P3 Canada (giang@yorku.ca)

Introduction: The Northern Polar Layered Deposits (NPLD) of Mars have been an area of great interest to scientists studying the climatology of Mars. At the largest scales, the identification of the migrating and spiralling troughs of the Martian North Polar Cap [1] has helped to understand atmospheric deposition of ice grains. Meanwhile, the modelling of katabatic winds [2] have revealed the presence of medium scale wind-sculpted features (sastrugi) aligned with the mean wind direction.

Despite this previous work, there is a lack of analysis of small scale textures on the NPLD smaller than 100 m. The HiRISE images provided by Mars Reconnaissance Orbiter provide an excellent tool for examining such features as the images, given the high resolution of as much as 25 cm/pixel on the NPLD. By examining several HiRISE images scattered across the NPLD, the size as well as the orientation of the features were measured. Such measurements provide insight into the processes which create these features.

Methods: A total of 57 HiRISE map-projected images were used to analyse features within the decametre range. From these large images, smaller, more manageable frames were extracted to find and analyze any patterns on the surface. Where surface textures changed across a single image multiple frames were extracted.

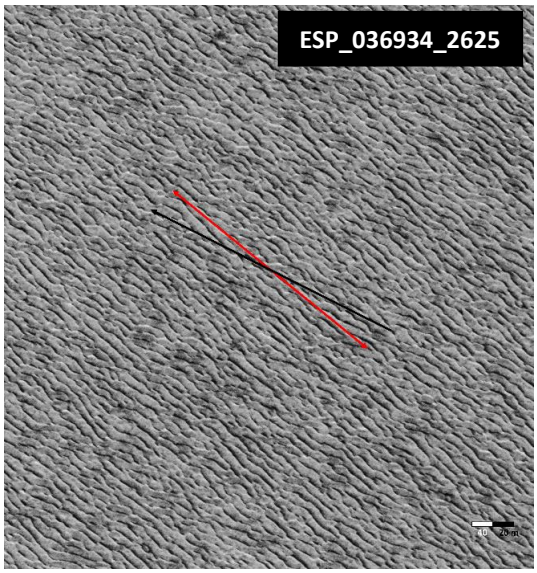

Fig. 1: *Frame extracted from HiRISE image. The black arrow points towards the north while the red line shows the general direction of the surface feature.*

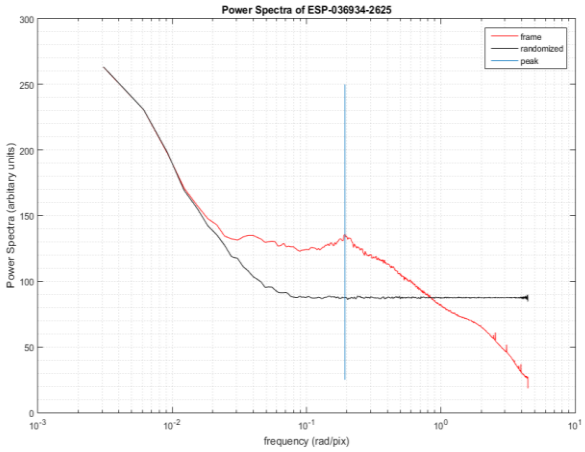

Fig. 2: *Plot of the power spectra corresponding to the image used in Fig. 1. The peak occurs at frequency 0.195 rad/pix at a scale of 0.25 m/pix which corresponds to a feature size of approximately 8 m.*

The size of the features was determined by spectral analysis [3]. A 2D Fast Fourier Transform was then used where the power was calculated across a spectrum of frequency representing the spacing of the surface features. By comparing the power spectra curve between the actual frame and a frame composed of white noise, peaks in spectral power correspond to the most prevalent feature sizes. These spectral power distributions were checked for coherence and by examining the extracted frames visually to ensure the features corresponding to each peak could be identified.

Orientation was defined as the angle between the direction of the features and the north-south axis.

Results: Of the 72 frames extracted from the 57 HiRISE images, 49 frames were found to have clear and consistent feature patterns throughout the frame. The average size of the features was calculated to be 21 ± 7 m while the average orientation is 39 ± 24 degrees away from the north-south axis.

The 49 frames that have consistent surface features varied significantly in spacing size as well as orientation. When plotted with respect to their location versus latitude, there were no observed trends in the distribution of spacing or orientation of the features. However, there were consistent feature patterns that appeared in several frames. There were also frames taken from the same image shown to have different features.

A selection of images show features of multiple scale. These larger features are approximately 200 m resembling sastrugi [2]. Often, within the sastrugi fields, the small-scale features contained are observed to have a different orientation than the larger feature nearby, which suggests either a different time of formation or a different formation mechanism.

Discussion: While grouping all the observed features together provides no general trend in the data, splitting the features into smaller sub-groups may show more prominent tendencies. This could be done by grouping visually similar features together or by categorizing features with respect to their specific region. The assumption here is that similar textures have a genetic relationship which may relate to a specific formation mechanism with different mechanisms responsible for the different size, orientation, and visual texture of each sub group.

Assessing how the features differ may also give useful information on the deposition process in Mars' northern regions. While sastrugi are mainly formed by the wind where their presence on the Martian Polar Cap is likely to have been formed by katabatic winds, the smaller features within the larger ripples tend to not share the same orientation which hints at sources other than katabatic winds that drives the formation of small-scale features.

The diversity of patterns observed may give some insight into the formation of features by atmospheric processes. Terrestrially, solar driven features such as penitentes [4] have a strong east-west orientation tendency and is mostly limited to latitudes closer to the equator than 55º. If features close the polar cap with a dominant east-west orientation were to be found, they might suggest that it is possible for sublimation features to form on the NPLD.

Acknowledgement: The Lunar and Planetary Laboratory of the University of Arizona has been instrumental in conducting this research by providing the HiRISE images as well as vital meta information associated with each image.

References: [1] Smith, Isaac et Al. (2013) *Journal of Geophysical Research*. The spiral troughs of Mars as cyclic steps. [2] Herny, C. et Al. (2014) *Earth and Planetary Science Letters*. 56-66. [3] Moores et al (2015) *Advances in Space Research*, No. 55, 2217-2238. [4] Cathles, L. Maclagan (2014) *Journal of Glaciology*, Vol. 60, No. 219, 147-154.

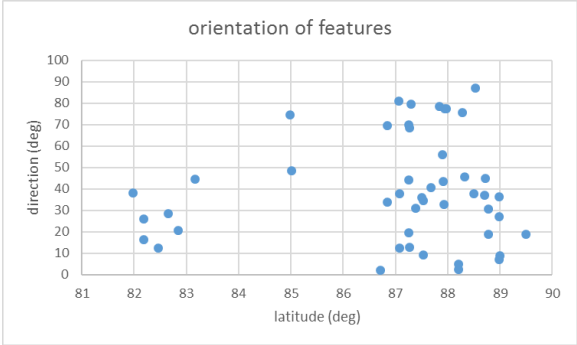

***Fig. 4**: Plot of preferred orientation of the surface features with respect to latitude. (90 degrees being perpendicular to the north-south axis which means dominantly east-west features while 0 degrees shows dominantly north-south*

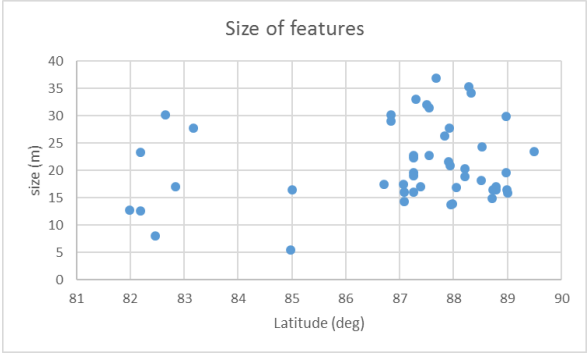

***Fig. 3**: Plot of the size of the features of the frames with respect to latitude.*