LATITUDINAL VARIATION IN SAND FURROWS IN THE NORTH POLAR REGION OF MARS. M. C. BOURKE[1] and Z. MCGALEY-TOWLE[1], [1]Department of Geography, Trinity College Dublin, Ireland, bourkem4@tcd.ie .

Introduction:

Sand furrows are geomorphic features that occur seasonally on the surface of aeolian sand dunes in the Polar Regions of Mars [1]. They are eroded during movement of gas during sublimation of the seasonal CO_2 ice [2]. They are important geomorphic features occurring on 95% of polar dunes. The process of cryo-venting mobilizes geomorphologically significant volumes of sand to the interdune for subsequent transport [3]. Previous work has noted the spatial variation in the distribution of furrows both on individual dunes and at different Polar locations.

Here we report on the preliminary findings of a mapping project that seeks to quantify and explain spatial and temporal variations in furrow distributions on polar dunes.

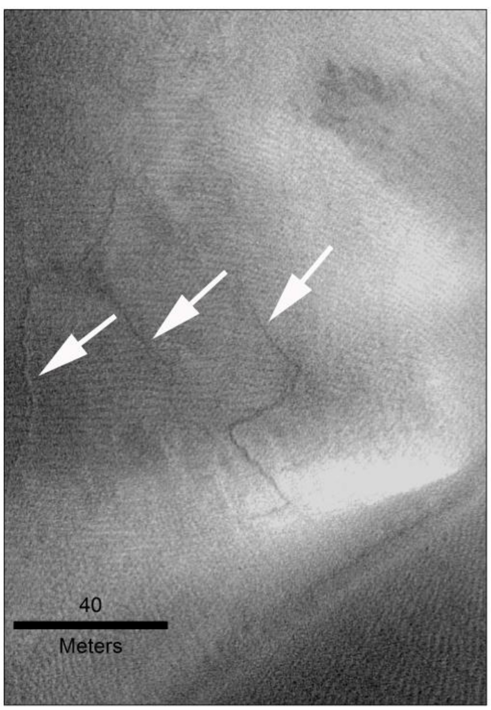

Figure1: Sand furrows on dunes at site 9 (see Fig. 2) in the North Polar Region of Mars. Furrow patterns are rectilinear. This is similar to polygonal cracking patterns in the seasonal ice cover. Subset of HiRISE ESP_026851_2590.

Methods:

Site selection: Furrows are small scale features (averaging 1.5 m wide, <90 m long and <.25 m deep) [1] and are only detected in HiRISE Images. A survey of available HiRISE images was conducted in the region between 270 and 330ºE and 70 and 80ºN. The following criteria were met for site selection: First the images must be ice free; second they must contain sand dunes, third that should be imaged during the same Mars Year and forth, they should be taken within a narrow L_s range.

A selection of ten sites was made from the image pool (Fig. 2). The sites reflect a latitudinal range of 9.5º that coincides with the mapped extent of the polar sand dunes [4]. The images were acquired between 16/2/2012 and 31/05/2012, over a period of 105 earth days or 47.3 Sols. Nine of the ten sites have a pixel scale of 25 cm.

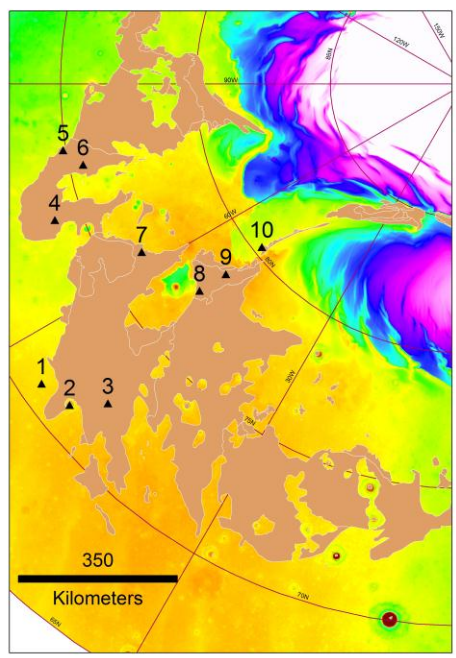

Figure 2: Location of ten sample sites identified for the sand furrow mapping survey. The tan coloured polygon is the extent of mapped polar sand dunes from Hayward et al, (2010).

Furrow location mapping: A quadrat was overlain on each HiRISE image. Sand furrow mapping was confined to grid squares along a central transect that ran parallel to the HiRISE image swath direction (Fig.3). Sand furrow location was mapped in ARCGIS using point data. Similar to previous studies, only clearly visible sand furrows were mapped [1]. The data reported here are therefore conservative values. The area of sand dunes was estimated by drawing polygons around the dunes in each sampled grid. Sand furrows have not been reported from the interdune and occur only on sand deposits [1].

Results: Data collection at four of the ten sites has been completed (i.e. sites 2, 5, 8 and 9) (Fig. 2). The locations of 1711 sand furrows have been mapped in an 84 km^2 area of sand dunes. Furrows have been detected at all sites. Furrow density was calculated by using the number of furrows recorded for the surveyed sand dune area at each site. Sand furrow density is 4.3/Km^2 at site 2 (the lowest measured to date); 10.7/Km^2 at site 5; 33.1/ Km^2 at site 8 and 25/Km^2 at site 9.

Mapping indicates that furrows are preferentially located at the base of the windward-facing and lateral dune slope. They are also located close to the dune brink. They are less frequently observed beginning on the avalanche face or on the middle of the windward slope. In dunefields with more complex dune morphologies, such as the presence of superimposed secondary ridges, the furrows were preferentially located at changes of slope between the primary and secondary bedforms.

Dune windward slopes face multiple directions from W through NW, NE to E. Mapping data, so far, do not indicate a dependency of furrow location on dune aspect.

Discussion: The data show that there is variability in the density of furrows at different sites in the Polar Region. While data from all ten sites will be required to fully test the assertion of a latitudinal control on furrow formation, it is worth noting that the two most northerly sites have a significantly higher density of furrows compared to the two lower latitude sites. The seasonal ice thickness increases pole-ward on Mars [5]. This suggests that there may be a threshold ice thickness for effective vent, and therefore furrow, development.

It is worth noting that the lowest density value of furrows, mapped so far, occurs in an intercrater dunefield (71.164ºN; 309.045ºE). The dunefield surface is located 100 m below the crater rim. Atmospheric models of crater winds show high directional variability and the generation of topographically increased wind speeds [e.g., 6, 7]. Such surface-atmospheric interactions would alter both the thickness of seasonal ice deposit and the potential preservation of furrows. The topographically-forced winds may increase ripple migration rates, thereby reducing furrow preservation.

The preferential location of furrows at locations of change in slope on dunes is consistent with earlier qualitative observations. Indeed it strengthens the assertion that slope-induced stresses in seasonal ice may be an important control on vent formation, and therefore sand furrow formation [2].

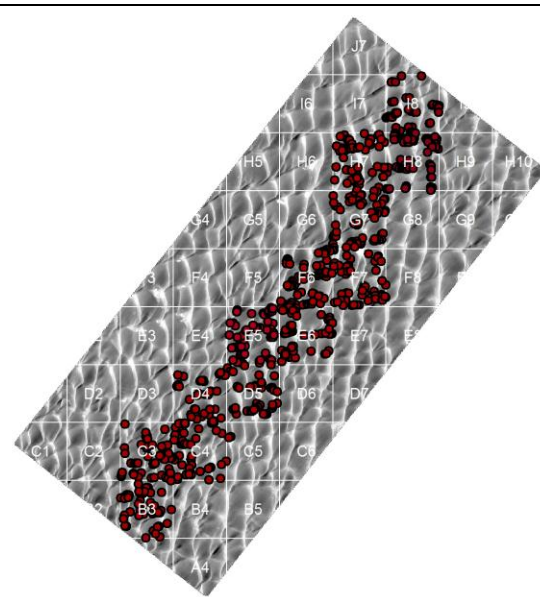

Figure 3: Example of furrow mapping at site 8. HiRISE image ESP_027405_2575.

References: [1] Bourke, M.C. and A. Cranford. (2011) Fifth International Conference on Mars Polar Science. [2] Bourke, M.C. (2013) 44th LPSC. Houston, TX, abs.# 2919. [3] Bourke, M.C. (2013) EGU2013-11859, Vienna. [4] Hayward, R.K., et al., (2010) Open-File Report 2010-11702010, U.S. Geological Survey. [5] Hansen, C.J., et al., (2013). Icarus, 225(2). [6] Hayward, R.K., et al, (2009). JGR, 114. [7] Rafkin, S. and Michaels, T.I., (2003). JGR (Planets), 108(E12), 10.1029/2002JE002027.