LATITUDINAL TRENDS IN MORPHOLOGY AND CLASSIFICATION OF SOUTHERN MARTIAN DUNES. A. Butcher,[1] and L. Fenton[2], [1]California Polytechnic University, Pomona, 3801 West Temple Avenue, Pomona, CA 91768-2557, [2]Carl Sagan Center, NASA Ames Research Center, MS 245-3, Moffett Field, CA 94035, USA.

Introduction: Terrestrial dune formation is dependent upon sediment availability, wind direction and transport capacity, all of which may vary with climate change. By studying dunes, it is possible to gain insight into the climate and sedimentary history of a region e.g., [1]. Martian dune fields are likely regulated by many of the same aeolian, climatic, and sedimentary processes. Southern hemisphere Martian dunes display latitudinal trends in classification and morphology as observed in HiRISE images. Many of these latitudinal changes are likely controlled by changes in the volume, depth, and stability of ice within the dunes at higher latitudes [2-3]. By locating these latitudinal trends and investigating the mechanisms controlling their formation, we can better understand the processes taking place within the region. Here, we utilize HiRISE images to investigate these latitudinal trends (Figure 1) and make polygons in JMARS to update the surface area estimates and by using isochrons, enabling an estimate of the crater retention age of dune surfaces in the high southern latitudes (Figure 2).

Methodology: Here, we studied a total of 80 HiRISE images between -50˚S and -80˚S (total study area ~16.9 x 10^6 km^2) [3], ranging in resolution from 25 cm/pixel to 100 cm/pixel. These images ranged from orbits 3325 to 18463, Earth dates 04-12-2007 to 07-05-2010. We only used non-cloudy, non-dusty images of ice-free surfaces, so that morphological features could be readily identified and cataloged.

Morphological Features and Latitude Correlation: Upon examination of the morphological features and correlation by latitude discussed by [4], several trends were noted.

Possible Mass Wasting/Gullying: HiRISE images revealed a total of 29 dune fields within the study area that exhibited signs of mass wasting and/or gullying between ~-50˚ S and ~-74˚ S. These appear to be more highly concentrated between ~-52˚ S and ~-58˚ S (Graph 1).

Degraded Ripples: A total of 43 dune fields exhibiting degraded ripples were found within the study area. Of these, some were noted to have intermittent areas of sharp ripples as well. Perhaps this is caused by different periods of aeolian activity in the area. The latitudes of these dune fields ranged from ~-51˚ S to ~-79˚ S with higher concentrations appearing between ~-56˚ S and ~-69˚ S (Graph 2). This is likely related to the overall decrease in ripples at higher latitudes.

Possible Grain Flow: Grainflow is a sign of recent to current dune activity. This process keeps the dune slip face at or near the angle of repose. The HiRISE images revealed 7 dune fields within the study area with signs of grainflow. These ranged in latitude from ~-50˚ S and ~-57˚ S and are the most distinct example of a latitudinal morphological trend found in this study (Graph 3).

Pitting: Although the cause of pitting is unclear at this point, several of the images showed pitting near areas with concentric white circles (possibly remnants of frost) around them, or dark streakes emerging from them. These features could possibly be related. A more in-depth study would be needed to confirm this theory. A total of 54 of the dune fields from this study showed signs of pitting, ranging from ~-51˚ S and ~-79˚ S.. Of these, nearly all of the dune fields at latitudes south of ~-61˚ S showed signs of pitting (Graph 4).

Polygons: Polygons on Mars are a widely observed feature. It is believed that their formation is likely a function of permafrost and ice wedging; and that the shape, size, and density of these features is related to years of freeze and thaw. Linear, widely spaced polygons are believed to have gone through fewer cycles of freeze and thaw, while more polygonally shaped, small, dense areas are believed to have gone through more of these cycles. Until recently, none of these features were observed on Martian dunes [5]. My study revealed 15 dune fields between ~-51˚ S and ~-74˚ S with evidence of polygons in the dunes, with the highest concentration being between ~-67˚ S and ~-74˚ S (Graph 5).

Surface Area and Crater Count Isochron: No craters were identified in the HiRISE images of dunes. Dunes imaged by HiRISE spanned a surface area of 1849.6 km^2. Using isochrons from [6] and following the method of [7], an upper limit crater retention age for the dune surface may be estimated. Under the assumptions that one or fewer craters of diameter 3 m or greater exist on the dunes, and that all the dunes were the same age, the estimated crater retention age is ~≤ 100 yrs.

Discussion: The five morphological features show evidence of latitudinal trends. The latitudinal end members of these trends tend to be near -60˚ S, which correlates to the edge of the high water-equivalent hydrogen content, considered to indicate the presence of water ice in the near-surface soil on Mars [8]. The features that imply higher activity and freedom of the grains to move such as mass wasting and gullying are concentrated at latitudes equatorward of this boundary. At latitudes near this boundary, we found higher concentrations of degraded ripples. This could be an sign of a gradual boundary, indicating that activity here was more recent than at the higher latitudes, but less recent than at the lower latitudes, or that slumping, distortion, and erosion from the stabilizing ice is less extensive at these latitudes. Poleward of the boundary we found higher concentrations of polygons and pitting, indicating that the mechanism that produces these features is likely either more dependent on the temperature and ice cores, or that it would have been more readily overwritten by activity at lower latitiudes. The new crater retention age is significantly lower than previous work suggests.

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Figure 2: Graph 6. Diameter v Crater Count. Assuming all dune surfaces in the study area are the same age, using an updated area of 1849.557 km^2, and assuming that there was ≤1 crater of ~3 m diameter, the crater retention age is ~≤100 yrs.

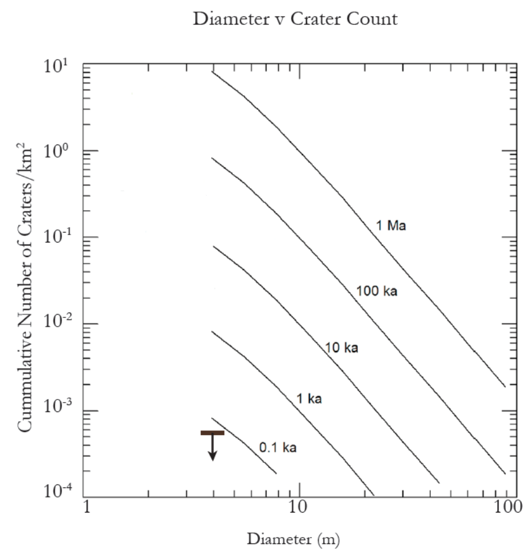

Figure 1: Latitudinal Trends of Morphological Features. Histograms in 1° bins number of dune fields with particular morphological features by latitude, in comparison to the latitude of all dune fields in the study