A COMPARATIVE ANALYSIS OF BARCHAN DUNES IN THE INTRA-CRATER DUNE FIELDS AND THE NORTH POLAR SAND SEA.

M.C. Bourke[1], M, Balme[2] and J. Zimbelman[3] [1]Planetary Science Institute, 1700 E. Ft. Lowell, Suite 106, Tucson, AZ 85719-2395 mbourke@psi.edu. [2]Dept. Space & Climate Physics, UCL, London WC1E 6BTUK balme@asu.edu [3] CEPS, NASM, Smithsonian Institution, Washington, DC 20013 jrz@nasm.si.edu.

Introduction: Martian sand dunes have the potential to contribute data on geological history through a study of their form. Recognition of the characteristics of both recent and ancient dunes is the first step towards understanding the present as well as past aeolian systems, and by proxy, climatic conditions on Mars. Dunes studied in detail in Viking 1 and 2 Orbiter images have been classified as barchan, barchanoid, transverse, and complex. Regionally, they are concentrated in four locations: The North and South Polar regions, in intra crater dune fields and in troughs and valleys. Here we present the results of a morphometric analysis of barchan dunes in two of these locations: the North Polar Sand Sea (NPSS) and intra-crater dunes.

Variable dune form on Mars: There is a wide range of barchan form on Mars (examples shown in Fig. 1). Dunes display both high and low length/width ratios, both well and poorly developed arms and also many are asymmetric. Many lack obvious slip faces and are more appropriately classified as dome dunes. The form variability may be used to indicate local conditions. For example, dune asymmetry is thought to indicate variable wind directions (e.g. [1]); increasing dune curvature might indicate higher wind velocities [2, 3]; dune forms are know to adjusts to sediment source proximity and volume; dune merging and absorption indicates variable rates of dune migration; a poor correlation of the windward slope with other slopes may indicate dune immaturity[4].

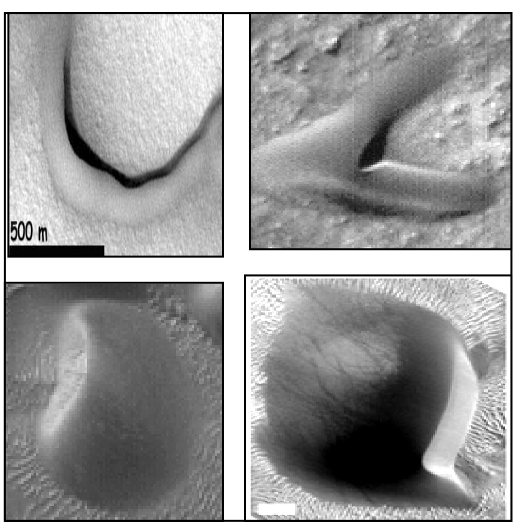

Figure 1. Variable crescentic dune morphology. Dunes are selected from the North Polar Sand Sea (top left) and intra-crater dune fields.

The dunes sampled from craters show morphological heterogeneity when compared to those in the NPSS. This may be related to topographically induced, variable wind regimes and relatively limited sediment supply in craters.

Methodology: In this pilot study of dunes we sampled 51 isolated crescentic dunes in the North Polar Sand Seas (215-265°W, 76-79°N) and intra-crater dune fields (350-320°W, 35-55°S). We follow the dune sampling methodology used by others[5]. Inherent assumptions are outlined in[6]. Dune volume is estimated from XYZ data points derived from narrow angle MOC data and processed in 3-D utilising the *Surfer* program. Sixteen data points sufficiently reproduce the dune shape, and dune volume can be calculated without making any assumptions about their shape (Fig. 2).

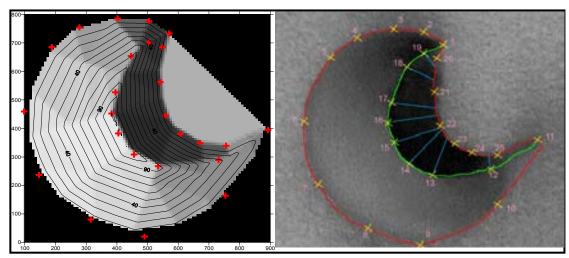

Figure 2. Sampling method for morphometric analysis (right). Output from Surfer program (left)

Results of morphometric analysis: Isolated crescentic dunes in the North Polar Sand Sea (MC-01) have a mean height of 48 m, length of 160 m, width of 290 m and a volume of 1.9 x 10^6 m^3. This revises the assumed height of 25 m that was previously used to estimate sand sea volume [7].

Dunes in the intra-crater dune fields have a similar height of 47 m, but are longer (275 m) and wider (430 m). They are also volumetrically larger (2.7 x 10^6 m^3). Although two dunes in the NPSS are significantly larger. These dimensions are similar to the Kharga barchan dunes in Egypt [8] (l=266 m; w=150 m) except for a significant difference in height (h=10 m) and therefore volume (3.5 x 10^5 m^3). See figures 3 and 4.

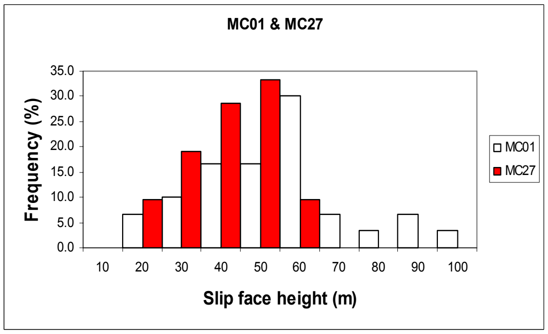

Figure 3 Histograms of dune height for samples in the NPSS and intra-crater dune fields.

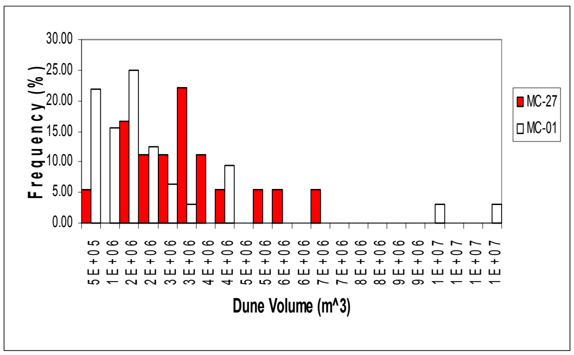

Figure 4 Histograms of volume estimates for samples in the NPSS and intra-crater dune fields.

Bivariate analysis Intra-crater dunes: The analysis was undertaken for dunes in both sample regions. Data for the intra-crater dune fields were poorly correlated. This suggests that they are not in equilibrium with airflow and might indicate conditions of net sand loss[4]. This is likely in craters with restricted sediment access.

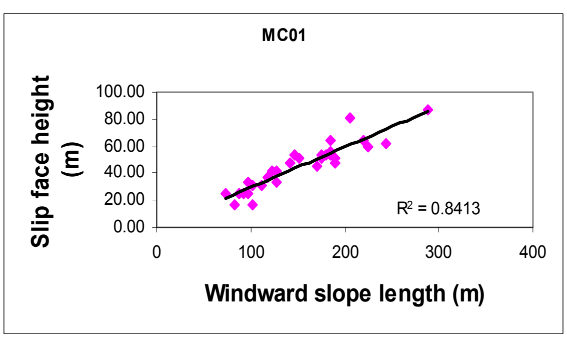

Figure 5 Bivariate plot of dune height and windward slope length for North Polar Sand Sea barchan dunes.

North Polar Sand sea: Dune height shows strong linear positive correlation with dune width and length (Fig.5). Dune length also correlates with width. These data are similar to many findings for Earth and indicates that these dunes are in equilibrium [9-11]. Dune volume has an exponential relationship with dune length and height but not width. This suggests that barchan dune form may vary with scale.

Conclusion: In the sample populations, dune scale is similar to barchans on Earth.

Crescentic dunes in the NPSS differ from those in inter-crater dune fields, *i.e.,* they are less variable in form and are generally smaller (although there are some notable exceptions (Fig. 4). North Polar Sand Sea dunes appear to be in equilibrium. We find that, similar to Earth, they have strong linear relationships, e.g. dune height and length/width. Crescentic dune form in the North could vary with dune size. Intra-crater dunes do not correlate strongly and display a higher variability in form. We suggest that the topographic disruption of wind flow structure associated with crater rims and the variability in sediment supply is likely to be responsible for the poor correlations. In addition, the contrasting seasonal (frost) precipitation regimes are also likely to be an influence.

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