MARS GLOBAL DIGITAL DUNE DATABASE: DISTRIBUTION IN NORTH POLAR REGION AND COMPARISON TO EQUATORIAL REGION

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Introduction: The north polar portion of the Mars Global Digital Dune Database (MGD^3) extends map coverage of medium to large-size dark dunes to include the region from 65° N to 90° N, building on the previously released equatorial portion that spans 65º S to 65º N [1,2]. The north polar dunes, dominated by the vast polar erg, are concentrated in a band between 70° N and 83° N and cover approximately ten times as much area as equatorial dune fields. Approximately a third of the mapped dune fields in the north polar region have thick, continuous dune coverage, while the other two-thirds vary between dune fields with some bare interdune area and those that consist of widely scattered barchan dunes. A very small portion, less than 1%, of the dune field area consists of intracrater dune fields, in contrast to the equatorial region, where intracrater dune fields are responsible for approximately 70% of the total dune field area. Dune morphologies believed to form under unidirectional wind regimes, notably barchan, barchanoid and transverse, are seen in both equatorial and north polar regions. Linear dunes and modified barchans, that may indicate multi-directional winds, appear to be more common in the north polar region.

Methods: In the equatorial region we used Thermal Emission Imaging System (THEMIS) infrared (IR) images [3] to locate potential dune fields. In addition to those images, in the north polar region we used a 1:15 M scale geologic map [4,5]. In the equatorial region THEMIS visible (VIS) [3] and Mars Orbiter Camera narrow angle (MOC NA) [6] images were used to classify dunes. In the north polar region, high-resolution Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) [7] images, not available when the equatorial region was constructed, were also used for that task. Because dune coverage in the north polar region is continuous over large areas and because within those areas coverage can range from relatively thick, uninterrupted dune forms to widely scattered individual dunes, we subdivided and displayed the large expanses of dunes based on the relative spacing between dune crests (Figure 1).

Discussion: *Geographic Distribution of North Polar Dune Fields.* Most of the north polar dune fields occur between 70º N and 83º N (Figure 1). A total of approximately 835,000 km^2, more than 10% of the surface area north of 65° N, have been mapped as having some type of dune coverage. Approximately 210,000 km^2, shown in bright red in Figure 1, are densely covered with dune forms. The dunes are usually barchanoid or transverse with little or no bare interdune area. These densely covered areas tend to be concentrated in Olympia Undae and near the mouth of Chasma Boreale in Siton, Abalos, and Hyperboreae Undae (Table 1). Approximately 540,000 km^2, shown in reddish pink, have significant dune form coverage, but with some bare interdune area. This type of dune coverage is the most widespread, extending to the east and west of Olympia Undae and nearly encircling Planum Boreum. Approximately 86,000 km^2 have widely scattered dune forms. These areas, shown in pink, occur mostly between 0º and 55º E. If we exclude the widely scattered dunes, the total mapped dune area is approximately 750,000 km^2. This total is similar to Lancaster and Greeley's estimate [8] of 680,000 km^2 in the north polar erg.

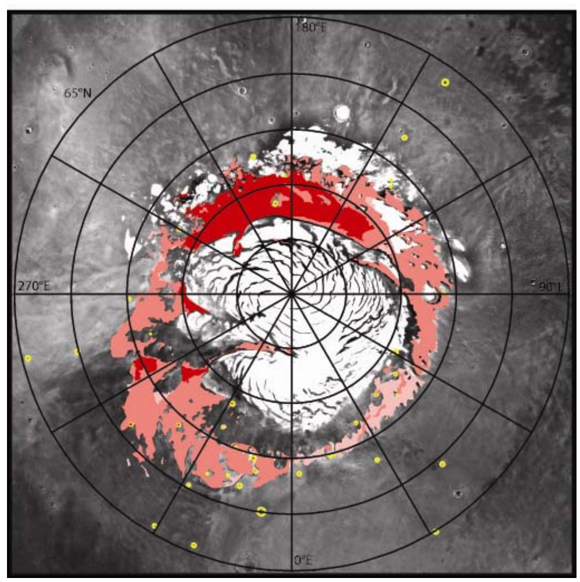

Figure 1. Distribution of dunes from 65ºN to 90ºN. Dune coverage ranges from dense (red) to intermediate (reddish pink) to widely scattered (pink). Also indicated are intracrater dune fields (yellow). Background is Viking MDIM (943m/pixel), Polar Stereographic projection, white surfaces are residual water ice.

Comparison of Intracrater Dune Fields in the North Polar and Equatorial Regions. In the north polar region, which is dominated by the polar erg, only

Table 1. Dune field distribution by longitude.

Relative spacing	Longitude Range (ºE)	Place Name	Area (km^2)
Dense	130 - 245	Olympia Undae	~185,00
Dense	260 - 310	Abalos, Siton and Hyperbo-reae Undae	~25,000
Inter-mediate	55 - 180	Olympia Undae and vicinity	~200,000
Inter-mediate	245 - 360	n/a	~300,000
Sparse	0 - 55	n/a	~90,000

about 40 craters contain dune fields. The area of the intracrater dune fields is ~1200 km^2, less than 0.2% of the total area covered by dune fields. The intracrater dune fields range in size from ~2 to ~150 km^2 with a mean size of ~30 km^2. By comparison, the equatorial region dune fields cover ~70,000 km^2, about 70% of which (~50,000 km^2) is accounted for by the ~400 dune fields that occupy craters. The intracrater dune fields range in size from ~1 km^2 to ~1900 km^2 with a mean of ~115 km^2. However, dune fields in the equatorial region are concentrated south of 30º S. There are only 8 northern equatorial intracrater dune fields between 30º N and 65º N. They cover a total of ~1500 km^2, with a range of 10 to 677 km^2 and a mean size of about 190 km^2. Thus, when the north polar region is compared to the northernmost equatorial band, the two regions have similarly small total intracrater dune field areas, although the individual equatorial dune fields tend to be larger.

Table 2. Comparison of intracrater dune field distribution in north polar, northern equatorial and equatorial regions.

Latitude range	No. of in-tracrater dune fields	Areal coverage (km^2)	Average dune field area (km^2)
65ºN-90ºN	41	~1200	~30
30ºN-65ºN	8	~1500	~190
65ºS-65ºN	428	~50,000	~115

Comparison of Dune Types in the Equatorial and North Polar Regions. There are many similarities in dune forms between the equatorial and north polar regions, especially those that form under unidirectional wind regimes, such as barchan, barchanoid and transverse dunes. Linear dunes, believed to form under a multi-directional wind regime, appear to be more abundant in the north polar region. Figure 2 shows some examples of dunes in the north polar region that may indicate multi-directional winds. Figures 2a and 2b show linear dunes (note in 2a, the linear dunes are forming from convoys of domes [9]). Figure 2c shows barchans with either transverse or linear dunes. Figure 2d displays a modified barchan with two slipfaces. In Figure 2e, the barchan has two slipfaces and a short linear tail.

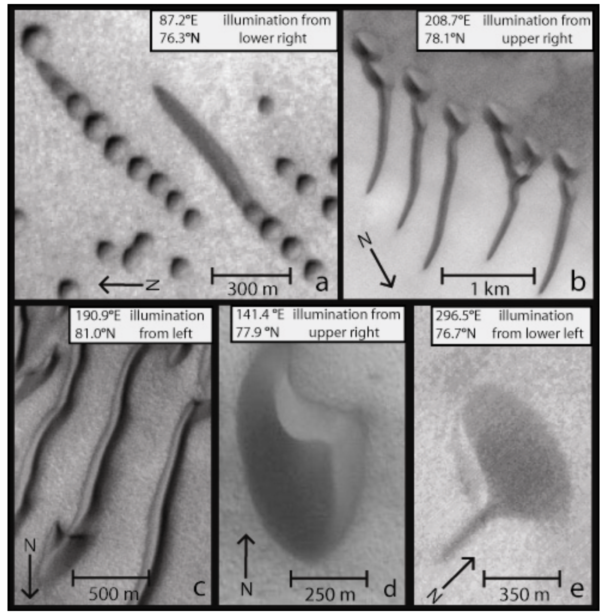

Figure 2. Parts of CTX (6m/pixel) and MOC NA images showing aspects of north polar dunes on Mars. (a) CTX P01_001608_2561_XI_76N273W, (b) CTX P02 _001709_2578_XN_77N149W, (c) CTX P01_001427 _2787_XI_81N170W, (d) MOC NA E0201255 (4.5m/ pixel), (e) CTX P02_ 001930_2566_XI_76N062W.

Summary: The expansion of the digital dune database to the north polar region makes it possible to quantify dune coverage between 90° N and 65° S. It is also possible to compare dune distribution patterns and dominant dune types present in the north polar region to those in the equatorial region.

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