MARS DIGITAL DUNE DATABASE: PROGRESS AND APPLICATION R. K. Hayward[1], K. F. Mullins[1], L. K. Fenton[2], T. N. Titus[1], M.C. Bourke[3], T. Colaprete[4], T. Hare[1] and P. R. Christensen[5], [1]U.S.G.S. 2255 N. Gemini Dr., Flagstaff, AZ 86001, rhayward@usgs.gov. [2] Carl Sagan Center/Ames Research Center, [3] Planetary Science Institute, Tucson, AZ, [4]NASA/Ames Research Center, [5] Arizona State University, Tempe, AZ.

Introduction: The Mars Digital Dune Database provides a comprehensive and quantitative view of the geographic distribution of dune fields from 65° N to 65° S latitude. The database encompasses ~ 550 dune fields, covering ~ 70,000 km^2, with an estimated total volume between 3,800 km^3 and 13,400 km^3. Over 1800 selected Thermal Emission Imaging System (THEMIS) infrared (IR), THEMIS visible (VIS) [1] and Mars Orbiter Camera Narrow Angle (MOC NA) images [2] were used to build the database.

The 100 m/pixel resolution THEMIS IR images were used to locate potential dune features. The higher resolution THEMIS VIS and MOC NA images were used to assign earth-based dune classifications. Where image quality allowed, slipface measurements based on gross dune morphology were digitized to represent primary wind direction responsible for that morphology. Azimuth values were calculated, from crater centroid to dune centroid, for dune fields located within craters. The azimuth, another possible indicator of wind direction, was compared to slipface measurements and to the included NASA/Ames General Circulation Model (GCM). Results of the comparison are presented by Fenton et al., (this volume). The geographic distribution of the dune fields was compared to another global dataset, the Viking-based Atlas of Mars 1:15,000,000 Geologic Series maps (USGS I-1802A-C) [3], to determine the age and type of geologic units beneath the dune fields.

The 65° N to 65° S latitude portion of the database, as well as a preliminary 65° to 90° S portion of the dune database, is currently being used to target new images by the High Resolution Imaging Science Experiment (HiRISE) and Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) instruments onboard the Mars Reconnaissance Orbiter.

Attributes of Dune Fields included in Database. For each dune field in the database, the following information is provided: longitude, latitude, a unique dune ID number based on longitude and latitude, dune classification, ID numbers of THEMIS IR, THEMIS VIS, and MOC NA images used, dune field area in km^2, estimated mean height of dune field, estimated volume based on area of dune field and mean dune height, a second estimated volume based on Mars Orbiter Laser Altimeter (MOLA) gridded topography [4], average elevation of dune field, and slipface orientation (if measured). In addition, the following information is provided for dune fields that are located within craters: crater ID number, crater centroid to dune centroid azimuth, crater diameter and crater area.

Discussion: *Geographic Distribution of Dune Fields.* A global dune database for Mars has the potential to address local to regional-scale processes by providing an important link between the geographic distribution of dune fields and their local, physical characteristics. The majority of dune deposits in the database are located in the Martian southern hemisphere, scattered across the highlands terrain (Figure 1). Table 1 provides a general summary of the distribution of dune fields based on latitude.

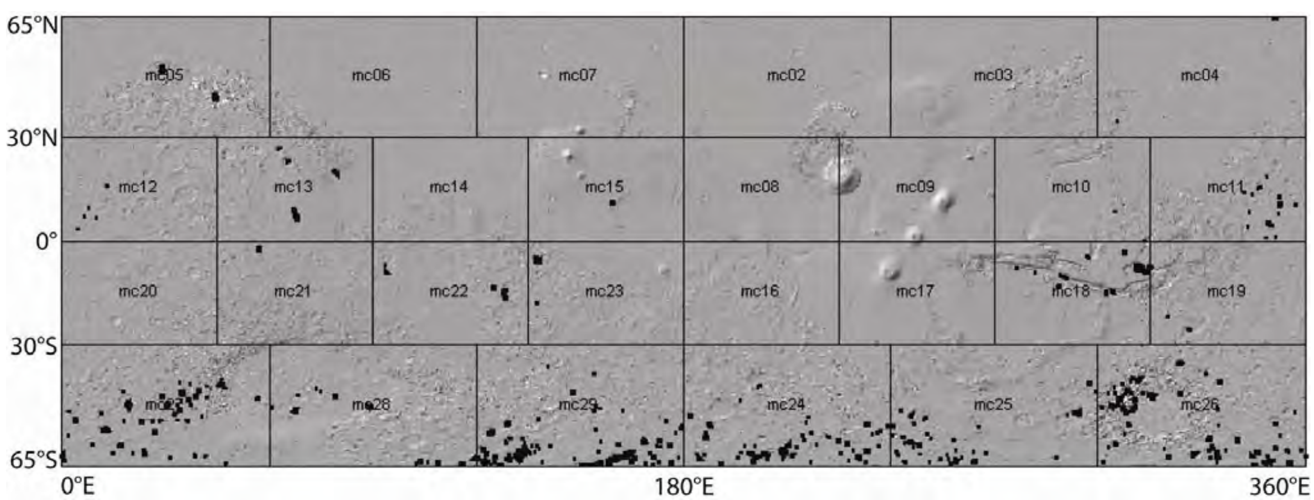

Figure 1. Geographic distribution of dune fields.

Latitude Range	# Dune Fields	% Total Dune Fields	Area (km^2)	% Area
30º to 65º N	8	1.5	1487	2.1
0º to 30º N	36	6.6	5165	7.4
0º to 30º S	37	6.7	13,275	19.1
30º to 65º S	465	85.2	49,614	71.3
Total	546	100	69,540	99.9

Table 1. Dune field distribution by latitude.

Within the latitudinal trends, longitudinal trends can also be discerned. Of the 36 dune fields in the 0° to 30°N band, 33 dune fields are located between 340°E and 80°E (quadrangles MC-11 through MC-13). They contain ~ 97% of the ~5200 km^2 total area of dune fields within the 0° to 30°N band. Between 0° and 30°S latitude, 24 of the 37 dune fields, with a combined area of ~ 9500 km^2, are concentrated in and around Valles Marineris between 265°E and 315°E longitude. A trend that is clear across all geographic locations is that the majority of dune fields, 78%, totaling nearly 50,000 km^2, are located on crater floors.

Classification of Dune Fields. We used the earth-based classification of McKee (1979) [5] to identify dune forms. We currently include barchan, barchanoid, dome, linear, star, transverse, and (for bodies of sand with no discernable shape) sand sheet. When a dune field encompasses more than one dune type, it is given multiple classifications. For example, a single dune field could be classified as barchan, barchanoid and transverse. Thus Table 2, which summarizes our dune form classification, totals over 900 classifications for 546 dune fields. A classification of "unclassified" covers dunes that have not yet been classified, commonly due to a lack of suitably detailed images. The most intriguing "unclassified" dune forms are those that may have been influenced by local topography or environmental conditions unique to Mars, causing them to not readily fit the earth-based dune classification system.

Dune Type	Number of Type Assigned
barchan	144
barchanoid	261
dome	8
linear	27
sand sheet	128
star	5
transverse	91
unclassified	275

Table 2. Summary of dune classifications.

Dune field association with underlying Geologic Units and Ages. As an example of how the database can be used with existing global coverages to quantify relationships, we compared the geographic distribution of the dune fields to ages of geologic units in the Viking-based Atlas of Mars 1:15,000,000 Geologic Series maps (USGS I-1802A-C) [3]. An intersection of dune fields and geologic units shows that dune fields are located on 29 of a possible 95 distinct geologic units. Three of these, cs (impact crater material, superposed), cb (impact crater material, buried or partially buried) and s (impact crater material, smooth floor) are not associated with an age. For dunes intersecting those units, we use the age of the adjacent geologic units. Some dune fields span more than one geologic unit. For those we include all adjacent units. Thus an intersection of dune fields and geologic units yields ~ 650 ages which are summarized in Figure 2. Dune fields are underlain by geologic units of Amazonian, Hesperian and Noachian age, suggesting that if all dune fields were deposited at the same time they are Amazonian in age or that dune formation took place throughout Martian history. Given that the majority of dune fields occur in the southern highlands, it is not surprising that the majority of dune fields are associated with Noachian age geologic units.

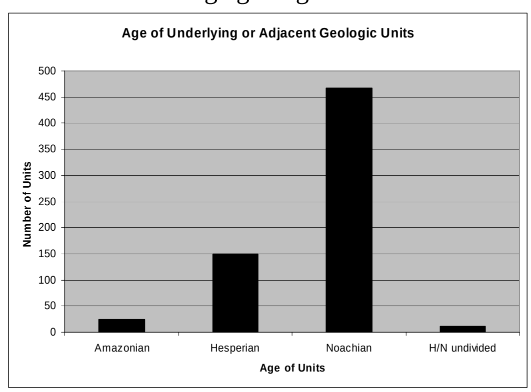

Figure 2. Age of underlying or adjacent geologic units.

Summary: The digital dune database makes it possible to look at dunes in a global context, comparing their geographic location and attributes to other global coverages, such as geologic maps, GCMs, MOLA and TES. Such comparisons provide significant perspective on local, regional, and global-scale aeolian processes that have shaped and continue to influence the surface of Mars.

References: [1] Christensen, P.R., et. al., THEMIS Public Data Releases, PDS node, ASU, http://themis-data.asu.edu. [2] Malin, M.C., et. al., Malin Space Science Systems Mars Orbiter Camera Image Gallery http://www.msss.com. [3] Skinner Jr., J. A. et al. (2006) *LPS XXXVII,* Abstract #2331. [4] Smith, D., et. al., (1999), Mars Global Surveyor Laser Altimeter Precision Experiment Data Record, NASA PDS, MGS-M-MOLA-3-PEDR-L1A-V1.0. [5] McKee, E.D. (1979). In: E.D. McKee (Editor), USGS Professional Paper 1052.