MARS GLOBAL DIGITAL DUNE DATABASE: COMPOSITION, THERMAL INERTIA, AND STABILITY. A.L. Gullikson[1*], R.K. Hayward[1], T.N. Titus[1], H. Charles[2], L.K. Fenton[3], R.H. Hoover[4], and N.E. Putzig[5], [1]U.S. Geological Survey, Astrogeology Science Center, 2255 N. Gemini Drive, Flagstaff, AZ 86001 *agullikson@usgs.gov, [2]University of Arizona, Tucson, AZ, [3]SETI Institute, Mountain View, CA, [4]Southwest Research Institute, Boulder, CO, [5]Planetary Science Institute, Lakewood, CO

Introduction: In response to the influx of new data collected for dune deposits across Mars from orbital and rover missions, a comprehensive database referred to as the Mars Global Digital Dune Database (MGD^3) was constructed [1]. It was compiled and released as three parts, the North Polar (65°–90°N) [2], the Equatorial (65°N–65°S) [3], and the South Polar (65°–90°S) [4] regions as USGS Open-File Reports. The database records the geographic distribution of medium to large-scale dune fields (>1 km^2 in size) within the latitude range of 90°N to 90°S, and includes a classification of dune morphology, slipface measurements, and estimated volume of sediment. Data presented here is an extension of the previously released MGD^3 Open-File Reports, and includes a detailed compositional analysis for dune fields ≥300 km^2 in area, thermal inertia values, a dune stability assessment, and results from two-component heterogeneity modeling. These additional datasets are divided into two separate spreadsheets: Equatorial (EQ) and South Polar (SP) regions. Both spreadsheets reflect the same range in latitude as their corresponding MGD^3 regions, with the exception of the Stability Index data in the EQ spreadsheet, which covers an area from 65°S-75°N. The continued goal for the MGD^3 is to provide a reliable and multifaceted depository of data for martian dunes, with the intention for such data to be easily accessible and used for future research.

Each of the additional sections that have been added to the MGD^3 will be briefly discussed below.

Tracks Worksheet: Each Tracks worksheet comprises detailed dune field observational data acquired from the Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES). The term "tracks" refers to the ground tracks from which TES collects surface observation data. Due to time limitations, this detailed analysis (including the **Mineral Worksheet** section below) was confined to dune fields ≥300 km^2 in size and resulted in a total of 58 dune fields in the EQ region, and 51 dune fields in the SP region. A Tracks worksheet was created for every analyzed dune field. Data listed in each Tracks worksheet were analyzed with JMARS [5,6], and includes two sets of data labeled daytime thermal inertia and nighttime thermal inertia. These labels refer to the type of parameters/templates that were used in JMARS to extract data, though there are additional data beyond thermal inertia included in both datasets. Data include, but are not limited to: TES Lambertian albedo, thermal inertia from TES bolometer and spectrometer, uncertainty ratings for thermal inertia, and derived surface temperature.

Mineral Worksheet: A Mineral worksheet contains modeled compositional abundances and uncertainties for all dune fields included in the Tracks worksheets. Dune fields are characterized by both endmember minerals and mineral-group abundances. TES emissivity data was first extracted in JMARS and then processed using DaVinci, a free programming tool developed by ASU [7,8]. An atmospheric-correction algorithm was first run to remove atmospheric endmembers based on the deconvolution method of [9-11]. An unmixing algorithm [11,12] that uses a mineral spectral library [i.e., 13,14] in conjunction with a non-negative least squared fitting routine [15,16] was then run to generate a bulk mineralogy assemblage with an accuracy and detection threshold of 10–15% [e.g., 17-20]. Two sets of data were generated using this method: an endmember mineral assemblage comprising 44 minerals and a mineral group assemblage consisting of 8 mineral groups (an example is listed in **Table 1**) [21].

Stability Index: A dune-field stability assessment was completed on both the EQ and SP regions. The term Stability Index (SI) is used as a measure of interpreted aeolian activity level in dune fields, ranging from potentially active to relatively inactive and eroding [22]. Thermal Emission Imaging System visible (THEMIS VIS), Context Camera (CTX), and Mars Orbital Camera (MOC) images were used to identify stabilization features >30 m in size. The assessment of these features enabled dunes to be classified on the basis of stability ranging from a potentially active dune field (classified as Stability Index 1) to sand sheets (classified as Stability Index 6). In addition to the Stability Index, High Resolution Imaging Science Experiment (HiRISE) images were used to identify small-scale (<10 m) stabilization features within dune fields in the EQ region, and this inclusion resulted in the expansion of the stabilization classification scheme.

Global Summary: The Global Summary section comprises averaged dune field compositional results, modeled errors, and the dune field's corresponding Stability Index value (e.g., **Table 1**). In this section, all normalized mineral group abundance percentages for a particular dune field were averaged together and errors were recalculated to determine an overall composition (original compositional modeled results are available in the Mineral worksheets).

TES Observation Data Summary: Data listed in this worksheet is a summary of all TES observation data acquired in the Tracks worksheets. Data for each ock

(MGS orbit number) analysis within a dune field were averaged and included in this worksheet (e.g., **Table 2**).

THEMIS ATI and Dune Modeling: The final major additions to the database are results from two-component heterogeneity modeling [23]. This model aims to identify the presence of subsurface volatiles by investigating thermophysical properties of dune fields located in the SP and EQ regions. Surface heterogeneities were identified using both TES and THEMIS apparent thermal inertia (ATI), i.e., were derived from single-point observations. Dependent on the extent of surface heterogeneities, dune fields were categorized into varying classes and types, which assisted in choosing the appropriate model (i.e., layered models or horizontally mixed models). Included in this worksheet are 171 dune fields that were chosen based on their size (dune fields larger than 0.25°x 0.25°) and morphology previously classified with the highest degree of confidence by [22].

Summary and Conclusion: The MGD^3 was first released as three separate USGS Open-File Reports, divided into the NP, SP, and EQ regions. The work presented here will be added to the MGD^3 and published as a USGS Open-File Report. Included in this publication will be Excel spreadsheets for the newly added data for both EQ and SP regions and a detailed description of the metadata, with the goal in mind to update and maintain a centralized depository of data for martian dune fields.

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Table 1. Sample of data for dune field 1640-615. Total RMS error is 0.17%, Stability Index is 2, and Confidence is 1

Feldspar	High-Si phase	Olivine	Pyroxene	Sulfate	Carbonate	Quartz	Hematite
31.1 (±13.0)	30.7 (±7.7)	2.6 (±4.8)	17.0 (±6.3)	9.9 (±4.8)	4.3 (±2.3)	1 (±1.5)	3.4 (±2.8)

Table 2. Excerpt from the TES Observation Data Summary worksheet for dune field 1640-615, in the EQ region. **Ock**=MGS orbit number; **Detector Range Low and High**=refers to the first and last observation of a particular ock over a dune field; **# of Det**.=total number of observational data points that were collected for an ock; **Low Temp and High Temp**= lowest and highest derived temperature recorded (K); **Avg. Bol.=**averaged thermal inertia from TES thermal bolometer (tiu); **Avg. Spec**.=averaged thermal inertia from TES spectrometer (tiu); **Local time**=local time at target (Martian hours); **Seas.**= season (heliocentric longitude); **MGS Clock**= time at beginning of observation (given in seconds, time began at 12:00 am, January 1, 1980); **Avg. Long**= averaged longitude of ock over dune field.

Ock	Detector Range, Low	Detector Range, High	# of Det.	Low Temp.	High Temp.	Avg. Bolo.	Avg. Spec.	Local Time	Seas.	MGS Clock	Avg. Long.
5575	603-6	612-1	32	198.9	208.8	293.2	257.5	1.15	286.5	6.33E+08	163.4
4921	594-4	599-1	28	207.1	209.5	392.1	332.1	1.75	253.0	6.28E+08	164.4
5336	594-4	598-4	24	208.4	210.5	374.9	316.5	1.36	274.4	6.31E+08	165.0
5009	595-4	598-1	13	207.0	208.4	354.5	301.6	1.67	257.5	6.29E+08	165.4