Open-File Report 2012-1259

SP_DuneTable_ReadMe.doc
Mars Global Digital Dune Database: MC-30

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(http:pubs.usgs.gov/of/2012/1259)

For: SP_DuneTable.xls, SP_Average_Slipface.txt, and SP_Dune_Field.txt

Overview of Tabulated Data Version:

The Mars Global Digital Dune Database (http://pubs.usgs.gov/of/2012/1259) is best viewed as one of the several common GIS vector formats made available. This includes nine shapefiles:
SP_Average_Slipface
SP_CcDcAzimuth_Line
SP_CcDcAzimuth_Point
SP_Crater
SP_Crater_Centroid
SP_Dune_Field
SP_Dune_Field_Centroid
SP_GCM
SP_Raw_Slipface
For non-GIS users, tabular softcopy versions of the Mars Global Digital Dune Database have been made available. They summarize most of the information in the database, except that found in the SP_GCM and SP_Raw_Slipface shapefiles. The tabular versions are available in Excel and ASCII file formats. The following information is organized as in the Excel file, **SP_DuneTable.xls,** but applies to both tabular formats.

Organization of Tabulated Data Version:

Worksheet 1 is the dune database attribute table. It consists of one table with 54 columns and 746 rows. It is also available as a tab delimited text file, SP_Dune_Field.txt.

Worksheet 2 is the list of Average Slipfaces and their Dune ID. An average slipface azimuth was calculated for dune fields with raw slipface measurements. That average is plotted in the average location of the group of raw slipfaces as an arrow (~200 records). It is also available as a tab delimited text file, SP_Average_Slipface.txt.

Metadata

Field Description and Details for Excel Worksheet 1 and Dune_Field.txt:

Field 1: Dune Field Lon+Lat ID – Each dune field has a unique ID number constructed after the method used by Barlow (2003) to assign ID numbers to craters. Longitude (east) is listed first and both values are extended to one decimal place. The + or – sign of the latitude is given, indicating the break between the two values. For example, 122.5 east longitude, -34.5 south latitude, would be denoted as 1225-345. The longitude is always four digits and the latitude is always three digits, filling in with leading zeroes where necessary.

Field 2: Dune Field Longitude (East) – This field records the position of the centroid of the dune field in decimal degrees east longitude.

Field 3: Dune Field Latitude (aerocentric) – This field records the position of the centroid of the dune field in decimal degrees latitude (aerocentric).

Field 4: In Original – The South Pole (SP) database includes some dune fields that would not have been included based on the criteria applied to the Equatorial (EQ) and North Pole (NP) databases. By selecting records with "yes" in this field, the user can choose to use only dune fields that would have been included in the other two portions of MGD[3]. Dune fields that would not have been included, either because they are sand sheets with no dune forms present, or because they do not appear to be dune fields in THEMIS IR, have a "no" in this field.

Yes = Dune field would have been included in EQ and NP databases.

No = Dune fields that would not have been included in EQ and NP databases, either because they are sand sheets with no dune forms present, or because they do not appear to be dune fields in THEMIS IR.

Field 5: Dune Type – This field lists the dune form type or types found within the dune field. It is often based on partial image coverage of the dune field and so may not include all dune forms present. Unless otherwise noted, we use dune forms as defined by McKee, 1979.

B – barchan dune as defined by McKee, 1979.
Bd – barchanoid dune as defined by McKee, 1979.
D – dome dune as defined by McKee, 1979.
L – linear dune as defined by McKee, 1979.
S – star dune as defined by McKee, 1979.
SS – sand sheet - used for a body of sand without dune forms.
T – transverse dune as defined by McKee, 1979.
U – unclassified – used for dunes that could not be classified, usually due to a lack of suitably detailed images.
Bull's eye – a term used informally by Fenton and Hayward, 2010, to indicate a dune field with successive concentric rings of sand.

Field 6: B – Barchan dune as defined by McKee, 1979.

1 – barchan dune present.
0 – barchan dune not present.

Field 7: Bd – Barchanoid dune as defined by McKee, 1979.
1 – barchanoid dune present.
0 – barchanoid dune not present.

Field 8: D - Dome dune as defined by McKee, 1979.
1 – dome dune present.
0 – dome dune not present.

Field 9: L - Linear dune as defined by McKee, 1979.
1 – linear dune present.
0 – linear dune not present.

Field 10: S – Star dune as defined by McKee, 1979.
1 – star dune present.
0 – star dune not present.

Field 11: SS – Sand sheet, used for a body of sand without dune forms.
1 – sand sheet present.
0 – sand sheet not present.

Field 12: T – Transverse dune as defined by McKee, 1979.
1 – transverse dune present.
0 – transverse dune not present.

Field 13: U – Unclassified, used for dunes that could not be classified, usually due to a lack of suitably detailed images, but may also be used when unusual dune forms do not fit earth-based classification.
1 – unclassified dune present, usually unclassified due to a lack of suitable detailed images.
0 – unclassified dune not present.

Field 14: BullsEye – Bull's eye dune as used informally by Fenton and Hayward, 2010.
1 – bull's eye dune present.
0 – bull's eye dune not present.

Field 15: Confidence:
1 – confident that feature is a dune field
2 – fairly confident that feature is a dune field
3 – not confident that feature is a dune field, will need better images to verify

Field 16: Image Types Used – Lists types of images used to locate/verify dune field.
C – Mars Reconnaissance Orbiter (MRO) Context Camera (CTX)
H – Mars Express High Resolution Stereo Camera (HRSC)

Hi – MRO High Resolution Imaging Science Experiment (HiRISE)
I – Thermal Emission Imaging System (THEMIS) Infrared (IR)
V –THEMIS visible (VIS)
M – Mars Orbiter Camera Narrow Angle (MOC NA)

Field 17: Dune Field Area (km^2) – Area of dune field polygon (km^2) calculated in sinusoidal projection to preserve area. Datum is Mars2000 sphere with 3396190 m diameter.

Field 18: Slipface Status – This field indicates whether slipface measurements were made for the dune field. "Yes" means that slipface measurements were made. "No" means that imagery was not sufficient for slipface measurement.

Field 19: Mean Dune Height 1 (m) – Mean dune height (m) used to calculate the volume for Method 1. MDH1 is based on (a) using the average MOLA elevation minus the minimum MOLA elevation as an estimate of the average dune height in a dune field and (b) placing dune fields into one of six groups depending on the assemblage of dune types within the dune field. MOLA elevation differences within a dune field, caused by underlying rugged terrain, will cause overestimation of dune height. To decrease the influence of rugged terrain, average dune height was calculated using only dune fields with a standard deviation (of elevation differences) equal to or less than that of the mean standard deviation of the interquartile range of the ~750 dune field polygons. The averages of the six groups derived from dune fields in more subdued terrain were applied to dune fields in more rugged terrain. This method still likely overestimates volume because of underlying topography.

Field 20: Volume Method 1 (km^3) – Volume 1 was calculated using the following formula: [MDH1]*.001*[Area_sinu_], where [MDH1] is the dune height (in meters, multiplied here by .001 to convert to km) assigned to the dune polygon and [Area_sinu] is the area of the dune polygon calculated in the sinusoidal projection. This is a very rough estimate of dune volume, chosen because it is similar to one of the methods used to calculate volume for the EQ database. It assumes that dune height would be the maximum minus the minimum MOLA elevation in a dune field. Underlying topography exaggerates dune elevation differences and results in an overestimation of dune height and volume. Another source of overestimation is the assumption that if the dunes were leveled the resulting thickness would be equal to half the dune height (average minus minimum). Studies on Earth have shown that sediment thickness of leveled dunes is significantly less than half the dune height (Lancaster and Greeley, 1990). Note that to make the total volume estimate consistent with the EQ volume estimate, include only dune fields with a "yes" in the "In_original" field.

Field 21: Mean Dune Height 2 – Mean dune height (m) used to calculate the volume for Method 2. MDH2 is based on measuring topographic profiles across representative dune crests using an ArcMap tool. In other areas, distance between barchan horns was measured. Terrestrial studies have found that dune height is roughly one tenth the distance between horns (for example, Finkel, 1959; Hesp and Hastings, 1998). Comparisons with Mars dune morphology suggest that the relationship may also be valid for Martian dunes (Bourke and others, 2006). As with MDH1, dune fields were categorized into six groups based on dune-type assemblage and a mean dune height was assigned to each category. Because profiles could not be measured on sand sheets, an arbitrary mean dune height of 1 m was assigned to the sand sheet category.

Field 22: Volume Method 2 – Volume 2 was calculated using the following formula: [MDH2]*.001*[Area_sinu]*[cover]*.5, where [MDH2] is the dune height (in meters, multiplied here by .001 to convert to km) assigned to the dune polygon and [Area_sinu] is the area of the dune polygon calculated in the sinusoidal projection and [cover] (not provided in the attribute table) is an estimate of how much of the dune polygon is covered with dunes. Although this is a rough estimate of dune volume, it does mitigate the overestimation due to underlying topography and is likely more realistic than the Volume 1estimate. Volume 2 probably still overestimates volume because, as in Volume 1, it assumes that if a dune were leveled, the resulting thickness would be half of the estimated dune height. Studies on Earth have shown that sediment thickness of leveled dunes is significantly less than half dune height (Lancaster and Greeley, 1990). This method was chosen because it is similar to a method used to estimate volume in the NP database.

Field 23: Dune Field Average Elevation (m) – The average elevation is given in meters. It was calculated for each dune field polygon using an ArcMap zonal statistics tool with MOLA (128 pixel/degree) gridded topography (in the SP Stereographic projection) as the value raster. The dune field polygons were in Sinusoidal projection. Note that the number of raster pixels used to calculate the average ranged from 3 for the smallest dune field to ~22,000 for the largest dune field. The average is more meaningful for the smaller dune fields.

Field 24: Crater to Dune Centroid Azimuth (Geographic) – This field is only populated for the dune fields that are located inside of craters and that meet the criteria for a meaningful CcDcAzimuth (~300). CcDcAzimuth is not calculated when a dune field is centrally located within a crater, when the crater floor is extremely rough, or when there are many scattered dune fields within a crater. ArcMap tools were used to create polylines that extend from crater centroid to dune centroid. The azimuth is given in decimal degrees calculated in Simple Cylindrical projection (for compatibility with the EQ and NP parts of MGD^3). We recommend that numerical comparisons to other azimuths be made in the Mercator projection because the Mercator projection preserves direction. Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters.

Field 25: Crater to Dune Centroid Azimuth (Mercator) – This field is only populated for the dune fields that are located inside of craters and that meet the criteria for a meaningful CcDcAzimuth (~300). CcDcAzimuth is not calculated when a dune field is centrally located within a crater, when the crater floor is extremely rough, or when there are many scattered dune fields within a crater. ArcMap tools were used to create polylines that extend from crater centroid to dune centroid. The azimuth is calculated in decimal degrees in the Mercator projection because that projection is best for preserving direction. We recommend using this field when comparing azimuths. Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters.

Field 26: Crater to Dune Centroid Azimuth (Stereographic) – This field is only populated for the dune fields that are located inside of craters and that meet the criteria for a meaningful CcDcAzimuth (~300). CcDcAzimuth is not calculated when a dune field is centrally located within a crater, when the crater floor is extremely rough, or when there are many scattered dune fields within a crater. ArcMap tools were used to create polylines that extend from crater centroid to dune centroid. The azimuth is calculated in decimal degrees in the SP Stereographic projection, to be used when plotting points on a SP Stereographic map. Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters.

Field 27: Slipface 1 Azimuth (Geographic) – The azimuth, given in decimal degrees, is the average of individual slipface measurements. It was calculated in the Simple Cylindrical projection (for compatibility with the EQ and NP parts of MGD[3]). We recommend using azimuths calculated in the Mercator projection (Fields 55-58) for comparison to other azimuths. Slipface method: Where THEMIS VIS, MOC NA, or CTX images of sufficient quality were available, polylines were drawn on slipfaces to measure the direction of wind movement at the time the gross dune morphology formed. It was beyond the scope of this report to look at the detail needed to discern subtle dune modification. It was also beyond the scope of this report to measure all slipfaces. We attempted to include enough slipface measurements to represent the general circulation (as implied by gross dune morphology) and to give a sense of the complex nature of aeolian activity on Mars. The absence of slipface measurements in a given direction should not be taken as evidence that winds in that direction did not occur. When more than one direction was recorded, slipface measurements were grouped and an average for each direction was calculated. Slipface1 is the direction with the greatest number of slipfaces used in the averaging process. Images were projected to ArcMap in the SP Stereographic projection using the Mars_2000 datum.

Field 28: Slipface 1 Count – The count is the number of individual slipfaces used to calculate the average.

Field 29: Slipface 2 Azimuth (Geographic) – The average of the direction with the second largest number of slipfaces used in the averaging process. It was calculated in the Simple Cylindrical projection (for compatibility with the EQ and NP databases). We recommend using azimuths calculated in the Mercator projection (Fields 55-58) for comparison to other azimuths.

Field 30: Slipface 2 Count – Slipface 2 Count is the number of individual slipfaces averaged to calculate the Slipface 2 Azimuth.

Field 31: Slipface 3 Azimuth (Geographic) – The average of the direction with the third largest number of slipfaces used in the averaging process. It was calculated in the Simple Cylindrical projection (for compatibility with the EQ and NP databases). We recommend using azimuths calculated in the Mercator projection (Fields 55-58) for comparison to other azimuths.

Field 32: Slipface 3 Count – Slipface 3 Count is the number of individual slipfaces averaged to calculate the Slipface 3 Azimuth.

Field 33: Slipface 4 Azimuth – The average of the direction with the fourth largest number of slipfaces used in the averaging process. It was calculated in the Simple Cylindrical projection (for compatibility with the EQ and NP databases). We recommend using azimuths calculated in the Mercator projection (Fields 55-58) for comparison to other azimuths.

Field 34: Slipface 4 Count – Slipface 4 Count is the number of individual slipfaces averaged to calculate the Slipface 4 Azimuth.

Field 35: Environment – Environment is a general description that divides dune fields into two main categories, those located within craters, C, and those located outside craters, N.

C – Dune field is located within a crater.

N – Dune field is not located within a crater.

Field 36: Crater Longitude (East) – This field records the position of the centroid of the crater in decimal degrees east longitude.

Field 37: Crater Latitude (aerocentric) – This field records the position of the centroid of the crater in decimal degrees latitude (aerocentric).

Field 38: Crater “BarlowID” – Many dunes fall within the topographic catchment of impact craters. Dune field position within the crater and the relative area of dune fields as a function of crater size and morphology might be indicative of prevailing wind conditions at the time of dune formation or proximity to a source of sediment. As such, we identify these craters for further study. Crater “BarlowID” is a unique ID number constructed after the method used by Barlow (2003) to assign ID numbers to craters. Longitude is listed first and both values are extended to one decimal place. The + or – sign of the latitude is given, indicating the break between the two values. Thus 122.5 east longitude, -34.5 south latitude, becomes 1225-345. The longitude is always four digits and the latitude is always three digits, filling in with leading zeroes where necessary. Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters. For example, Nili Patera is included.

Field 39: Crater Area (km^2) – Crater area, in km^2, is given when a dune field is located within a crater. When a dune field is located within a crater that is within one or more other craters, the innermost crater is considered to exert the most influence, so its area is used. Areas were calculated in the sinusoidal projection and are based on our digitized crater rims. Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters.

Field 40: Crater Diameter (km) – Crater diameter, in km, is given when a dune field is located within a crater. Diameter is calculated by formula based on the area of the crater. Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters.

Field 41: Mars 5M Chart – Mars Chart (1:5 million) number for quadrangle in which dune field is located.

Field 42: THEMIS IR Images – This field contains a comma delimited list of image numbers of Mars Odyssey Thermal Emission Imaging System (THEMIS) Infrared (IR) images used to locate dunes. Images are not included in the ArcMap or ArcReader versions of the database, but can be viewed or downloaded at http://themis-data.asu.edu/. The list is incomplete. The absence of image numbers does not imply a lack of THEMIS IR coverage.

Field 43: THEMIS VIS Images – This field contains a comma delimited list of image numbers of THEMISVisible (VIS) images used to verify location of, classify, or measure slipfaces of dunes. Not all images listed are included in the ArcMap and ArcReader versions of the database, but all can be viewed or downloaded at http://themis-data.asu.edu/.

Field 44: MOC NA Images – This field contains image numbers, unless otherwise noted, of Mars Global surveyor (MGS) Mars Orbiter Camera Narrow Angle (MOC NA) images used to verify location of, classify, or measure slipfaces of dunes. Not all images listed are included in the ArcMap and ArcReader versions of the database, but all can be viewed or downloaded at http://www.msss.com/.

Field 45: CTX Images – This field contains a comma delimited list of image numbers of Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) images used to verify location of, classify, or measure slipfaces of dunes. Images are not included in the ArcMap and ArcReader versions of the database, but can be viewed or downloaded at http://themis-data.asu.edu/.

Field 46: HiRISE Images – This field contains a comma delimited list of image numbers of MRO High Resolution Imaging Science Experiment (HiRISE) images used to verify location of or classify dunes. Images are not included in the ArcMap and ArcReader versions of the database, but can be viewed or downloaded at http://themis-data.asu.edu/.

Field 47: HRSC Images – This field contains a comma delimited list of image numbers of Mars Express High Resolution Stereo Camera (HRSC) images used to verify location of or classify dunes. Images are not included in the ArcMap and ArcReader versions of the database, but can be viewed or downloaded at http://themis-data.asu.edu/.

Field 48: WEB LINK 1 – This field contains a link to an internet site displaying an image of the dune field. Activate the link in ArcMap using the Layer Properties/Display tab.

Field 49: WEB LINK 2– This field contains a link to an internet site displaying an image of some dune fields. Not all dune fields have a second link. Activate the link in ArcMap using the Layer Properties/Display tab. Note that only one field can be hyperlinked at a time.

Field 50: Comments – This field contains comments.

Field 51: Slipface 1 Azimuth (Mercator) – The azimuth, given in decimal degrees, is the average of individual slipface measurements. It was calculated in the Mercator projection. We recommend this field for comparison to other azimuths.

Field 52: Slipface 2 Azimuth (Mercator) – The average of the direction with the second largest number of slipfaces used in the averaging process. It was calculated in decimal degrees in the Mercator projection. We recommend this field for comparison to other azimuths.

Field 53: Slipface 3 Azimuth (Mercator) – The average of the direction with the third largest number of slipfaces used in the averaging process. It was calculated in decimal degrees in the Mercator projection. We recommend this field for comparison to other azimuths.

Field 54: Slipface 4 Azimuth (Mercator) – The average of the direction with the fourth largest number of slipfaces used in the averaging process. It was calculated in decimal degrees in the Mercator projection. We recommend this field for comparison to other azimuths.

Field Description and Details for Excel Worksheet 2 (Average_Slipface) and Average_Slipface.txt

Field 1: Dune Field Lon+Lat ID – Each dune field has a unique ID number constructed after the method used by Barlow (2003) to assign ID numbers to craters. Longitude (east) is listed first and both values are extended to one decimal place. The + or – sign of the latitude is given, indicating the break between the two values. For example, 122.5 east longitude, -34.5 south latitude, would be denoted as 1225-345. The longitude is always four digits and the latitude is always three digits, filling in with leading zeroes where necessary.

Field 2: Average Longitude (East) – records the position of the point that represents the average slipface, in decimal degrees east longitude.

Field 3: Average Latitude (Aerocentric) – records the position of the point that represents the average slipface, in decimal degrees latitude (aerocentric).

Field 4: Slipface ID – The Dune Field Lon+Lat ID with a, b, c or d appended when multiple averages are calculated for a single dune field. This occurs when winds are multidirectional.

Field 5: Slipface Count – the number of raw slipfaces used to calculate the average slipface.

Field 6: Slipface Azimuth (Geographic) – The average slipface, in decimal degrees, for a given group of raw slipface measurements. It is calculated in the Geographic coordinate system (for compatibility with the EQ and NP databases). We recommend that numerical comparisons be made in the Mercator projection because the Mercator projection preserves direction.

Field 7: Slipface Azimuth (Mercator) – The average slipface, in decimal degrees, for a given group of raw slipface measurements. It is calculated in the Mercator projection. This value for the average slipface azimuth can be compared to the crater centroid to dune centroid azimuth because they were both calculated in the Mercator projection. We recommend that numerical comparisons be made in the Mercator projection because the Mercator projection preserves direction.

Field 8: Crater Dune Centroid Azimuth (Geographic) – ArcMap tools were used to create polylines that extend from crater centroid to dune centroid. The azimuth is calculated in decimal degrees in the Geographic coordinate (for compatibility with the EQ and NP databases). We recommend that numerical comparisons be made in the Mercator projection because the Mercator projection preserves direction. Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters.

Field 9: Crater Dune Centroid Azimuth (Mercator) – ArcMap tools were used to create polylines that extend from crater centroid to dune centroid. The azimuth is calculated in decimal degrees in the Mercator projection and so can be used for comparison to Slipface Azimuth (Mercator). Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters. We recommend that numerical comparisons be made in the Mercator projection because the Mercator projection preserves direction.

Field 10: Crater “BarlowID” - a unique ID number constructed after the method used by Barlow (2003) to assign ID numbers to craters. Longitude is listed first and both values are extended to one decimal place. The + or – sign of the latitude is given, indicating the break between the two values. Thus 122.5 east longitude, -34.5 south latitude, becomes 1225-345. The longitude is always four digits and the latitude is always three digits, filling in with leading zeroes where necessary. Note that the term "crater" was used for simplicity, even though a small number of the circular depressions containing dunes may not be impact craters.

Attribute Accuracy: All attributes were verified by displaying the lines and are believed to be logically consistent.

Logical Consistency Report: These data are believed to be logically consistent. Line geometry is topologically clean.

Positional Accuracy:

Horizontal Positional Accuracy:

The horizontal accuracy is derived from the accuracy of the Mars Orbiter Laser Altimeter (MOLA) dataset (Smith and others, 2001). The globally adjusted MOLA dataset has an absolute horizontal accuracy on the order of 100 m, but individual features in images can probably only be tied to MOLA-derived shaded-relief digital image models with a precision on the order of 200 m. Other bases used included Thermal Emission Imaging System (THEMIS) digital images (Archinal and others, 2003; Christensen and others, 2004). The digital features were drawn at 20K to 100K scale with a node spacing of approximately 0.3 km to 2 km.

Data Created: 11/2003 to 1/2012

Status of the data

Complete

Time period for which the data is relevant

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Constraints on accessing and using the data

Access constraints: none
Use constraints: none

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