Recent and Fossil Deposits of Dark Material in Martian Craters

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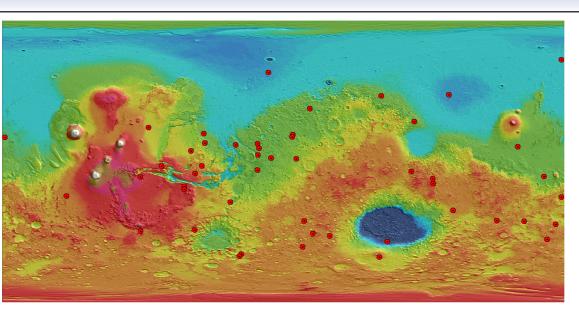
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INTRODUCTION

As a result of weathering and aeolian processes a fine-grained dark material is distributed all over the Martian surface. On crater floors it is frequently accumulated as dunes. Regionalscale controls cause a different morphology and particle size of the intracrater materials [1]. The aim of this study is to analyse the mobility activity of the aeolian material.

We have made a comparison between the actual wind fields and the main orientation of the dune formation. More over, the surface brightness temperatures were calculated to draw conclusions from the thermal conducivity of the dune surfaces.



For this analysis we have selected 50 craters with occurrences of aeolian dark dunes (Fig. 1). The database for the craters is HRSC-Data. High resolution MOC-images were used to analyse the dune shapes. For the actual wind directions modelled wind fields from the Mars Climate Database (MCD) are used. THEMIS night-time infrared data were used to get information about the brightness temperatures of the dune surfaces.

Fig. 1: Global overview of the 50 selected craters (background: MOLA shaded (DLR, ESA, FUB))

WIND DIRECTION DATA FROM THE MARS CLIMATE DATABASE (MCD)

The MCD is a database of statistics which describes the climate and surface environment of Mars. It uses two improved state-of-art general circulation models (GCMs) which are based on physical laws and prescribed parameters [2, 3]. These models were developed jointly at Laboratoire de Météorologie Dynamique du Centre National de la Recherche Scientifique, France, and the University of Oxford, United Kingdom, with support of the European Space Agency. For additional information concerning the theoretical background of the GCMs see [2] and [3].

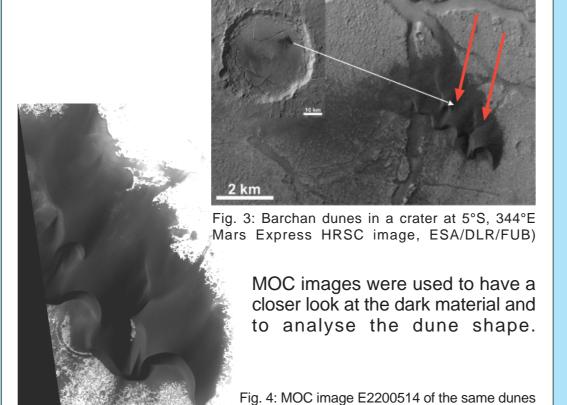


Fig. 2: Extract from the received MCD data for the craters of interest. Note that the crater names are in many cases not the official names but only names given here for this analysis pointing at the geographical

The data used for this analysis [Fig. 2] are yearly mean and maximum wind directions and wind amplitudes from 10 m above the surface of Mars. Additionally "daily" quantities were took into consideration to get information about the wind conditions prevailing at the acquisition date (solar longitude) of the HRSC data.

MORPHOLOGY-RELATED WIND DIRECTION

The dune morphology, more precisely the slip face orientation, clearly shows the direction of the wind that had built up the dunes. Most of the present dunes shapes are barchan dunes. These dune types have crescentic slip faces that are orientated downwind [4]. Transverse dunes are also often present. They have downwind orientated slip faces as well. In Fig. 3 this morphology-related wind direction is represented as red arrows.



BRIGHTNESS TEMPERATURES FROM THEMIS DATA

THEMIS night-time infrared data were used to derive the brightness temperatures (BTR) of the surface materials. The night-time surface temperature is closely related to the thermal conductivity of the materials and thus to the physical structure of the investigated object [5]. Fig. 5 shows a THEMIS mosaic of a crater at 15.8°N, 181.5°E with grey values. Fig. 6 shows a mosaic of the same crater where the grey values were converted into brightness temperatures.

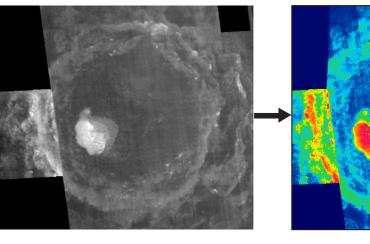


Fig. 6: THEMIS-BTR mosaic of I04594022, 106816025, 108289007 and 115128029.

Fig. 5: THEMIS mosaic of I04594022, 106816025, 10889007, 115128029 and I16950027. Bright colours indicate warm regions and dark colours indicate cold

Single THEMIS-BTR images show the absolute brightness temperature of the surface at the individual solar longitudes of the THEMIS scenes. Note that these THEMIS-BRT mosaics show normalised temperatures.

ANALYSIS AND RESULTS

Mobile dunes are built and shifted by the actual wind fields. If The loose (unconsolidated) fine-grained material which covers In the following Fig. 7 - 12 the maximum yearly wind directions fields the dunes can be assumed to be fossil.

warmer brightness temperatures at night it can be supposed that the surface could be consolidated.

the dune orientation does not coincide with the actual wind mobile dune surfaces cools at night more rapidly than coarse- from the MCD are marked as blue arrows and the wind directions grained sediments and solid rock [6]. If the dune surfaces have derived from the dune morphology are marked as red arrows.

correlative wind directions - cold surface: mobile dune?

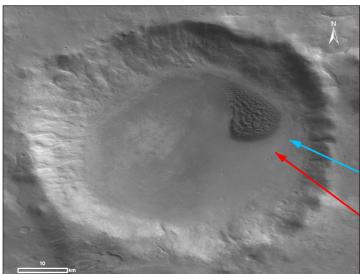
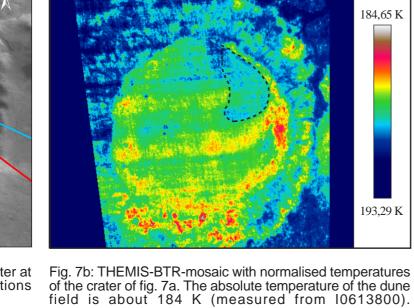


Fig. 7a: HRSC image of a barchan dune field in a crater at 44.2°S, 303.3°E showing correlative wind directions



of the crater of fig. 7a. The absolute temperature of the dune field is about 184 K (measured from 10613800).

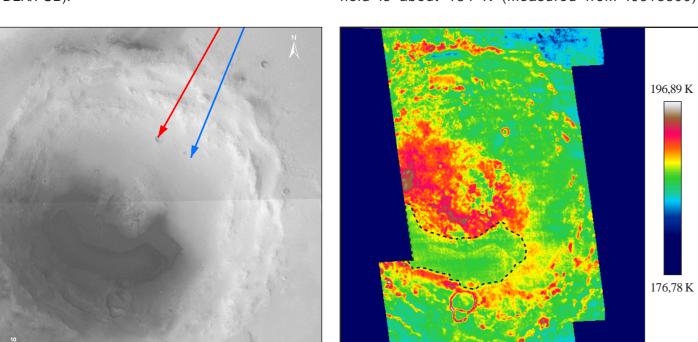


Fig. 8a: HRSC image of a barchan dune field in a crater at 9.6°N, 150.1°E showing correlative wind directions (ESA/DLR/FUB).

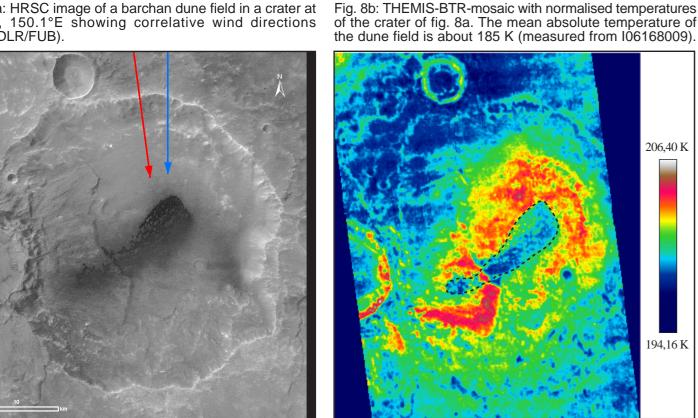
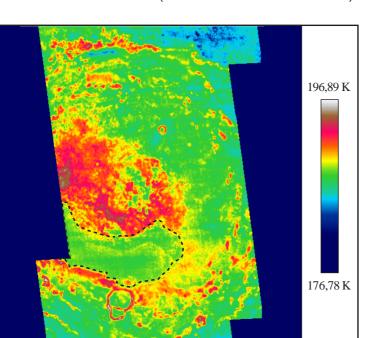
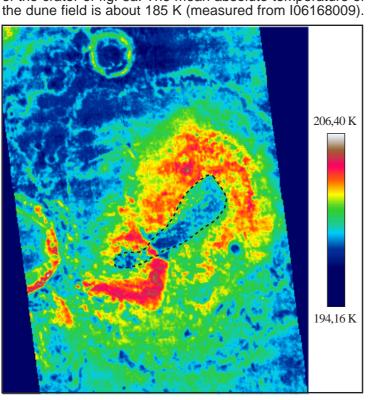


Fig. 9a: HRSC image of several barchan dunes in a crater at 14.3°S, 95.8°E showing correlative wind directions (ESA/DLR/FUB).



of the crater of fig. 8a. The mean absolute temperature of

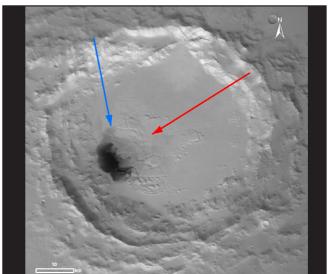


the dune field is about 196 K (measured from I06170007).

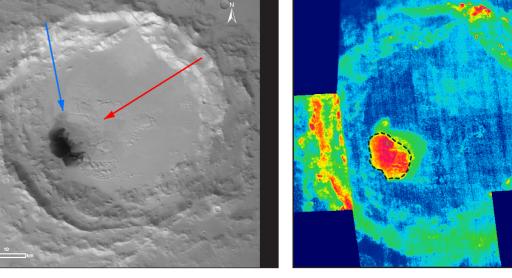
Fig. 7, 8 and 9 show dune fields with correlative morphology-related and actual wind directions. The BTRs of this dunes are apparent cooler than the BTRs of the surrounding indicating that they can consist of loos material.

The BTRs of the dark materials in Fig. 10b, 11b and 12b show that the dune formations are warmer at night than the surrounding. Thus it can be assumed that the dune surfaces could be consolidated. The divergent directions of the actual blowing and the morphology-related wind (Fig. 10a, 11a and 12a) confirm this assumption.

consolidation could be due to a CO2 frost layer. Therefor the absolute brightness temperatures of the dune surface were measured at wintertime THEMIS data. For all craters the measurments show values between 164 K and 199 K. These temperatures are to warm for CO2 frost [7].



We wanted to exclude the possibility that the specified in a crater at 15.8°N, 181.5°E showing divergent wind directions



divergent wind directions - warm surface: fossil dunes?

Fig. 10b: THEMIS-BTR mosaic of the crater of Fig. 10a with normalised temperatures. The absolute temperature of the dune field is 168 K - 176K (measured from 104594022).

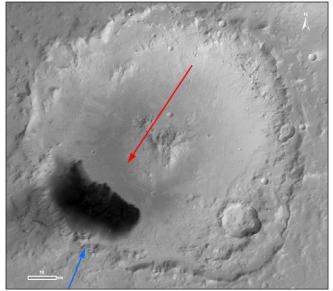
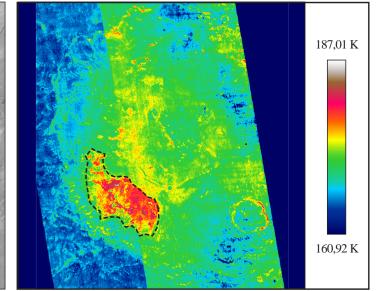


Fig. 11a: HRSC image of a barchan dune field in a crater at 25.8°N, 83.9°E showing opposite wind directions (ESA/DLR/FUB)



176,32 K

Fig. 11b: THEMIS-BTR mosaic of the crater of Fig. 11a with normalised temperatures. The absolute temperature of the dune field is 190 K - 195K (measured from 106707051).

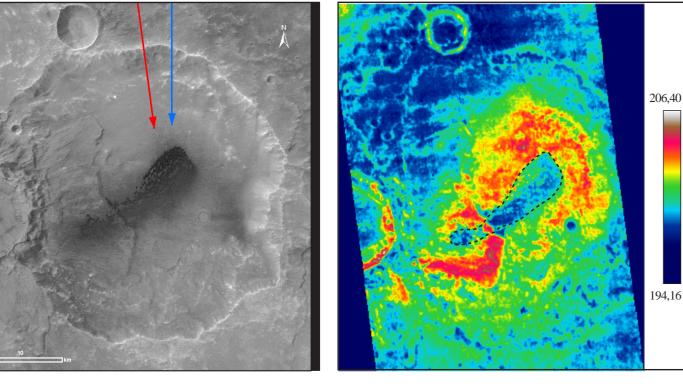


Fig. 9b: THEMIS-BTR-mosaic with normalised temperatures of the crater of Fig. 9a. The mean absolute temperature of

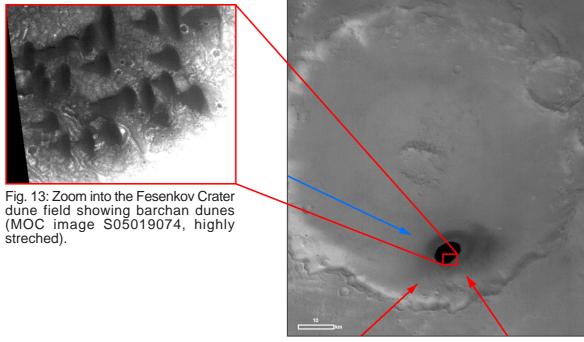
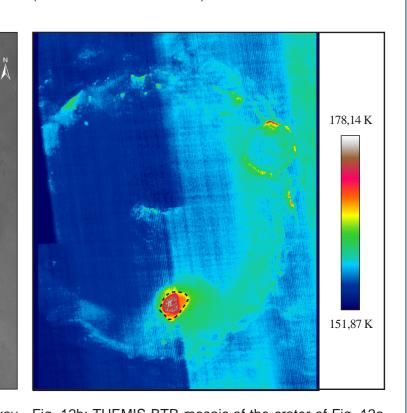


Fig. 12a: HRSC image of a dune field in the Fesenkov Fig. 12b: THEMIS-BTR mosaic of the crater of Fig. 12a Crater showing divergent wind directions (ESA/DLR/FUB).



with normalised temperatures. The mean absolute temperature of the dune field is about 164 K (measured from 106663012).

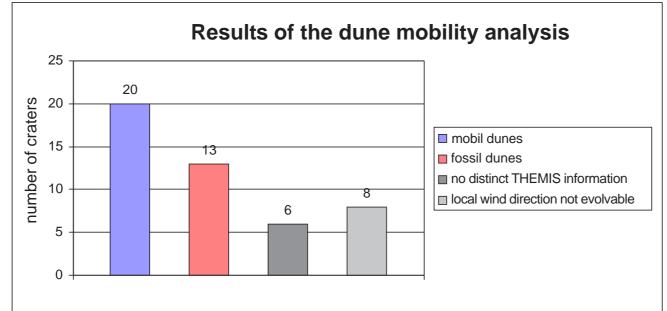


Fig. 14: Summarised results of the mobility analysis

analysis a bigger number of craters will be studied.

20 of the 49 studied intra crater dunes are assumed to be mobile 13 of the craters could possess fossil dune fields. For the rest of the studied craters it was not possible to make a conclusion:

It was either not possible to define the local wind direction or the THEMIS data show no obvious characteristic of the dark material.

CONCLUSIONS

40.8 % of the analysed dune fields show a good correlation with the actual wind fields and low night-time surface temperatures indicating that they might still be active. 26.5 % show divergent wind directions, suggesting fossil forms. The warmer BRTs of these dunes indicate

that the surface of these dunes does not consist of fine-grained loose material but could be consolidated.

This selective mobility and the analysis of the THEMIS-BTR data indicate fundamental differences in the physical surface properties of dark material dunes.

The measurement of the BTRs of the dune surfaces could exclude that the consolidation of the dune surfaces could be due to CO2 frost.

FURTHER WORK

In further analysis, the geographical distribution of mobile and fossil dune fields will be researched. For this

Additionally, other wind direction data from the MarsGRAM model should be involved. The purpose for this is to compare different data sets and to evaluate the reliability of the modelled data.

Furthermore the thermal inertia of the dune surfaces should be calculated. This information can be used to estimate the grain size of a material [6].

References:

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