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Analysis of diverse dune fields in Herschel Crater (Mars) from HiRISE datasets

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Introduction

Aeolian features are widespread on the Martian surface [1] and their morphology depends on wind regime and sediment supply; they preserve records of interactions between surface and atmosphere, and are defined as a ground truth for atmospheric models [2]. Recent studies using the High Resolution Imaging Science Experiment (HiRISE) [3] have allowed reexamination of dune fields unresolved by previous missions on a global scale [4][5]. In this work, we performed a detailed analysis of Aeolian features in a crater located at the southwestern edge of Herschel Crater in the Mare Tyrrenium region (MC22) (Fig.1). The use of HiRISE datasets allows us to see diverse Aeolian features and discern new details inside the crater.

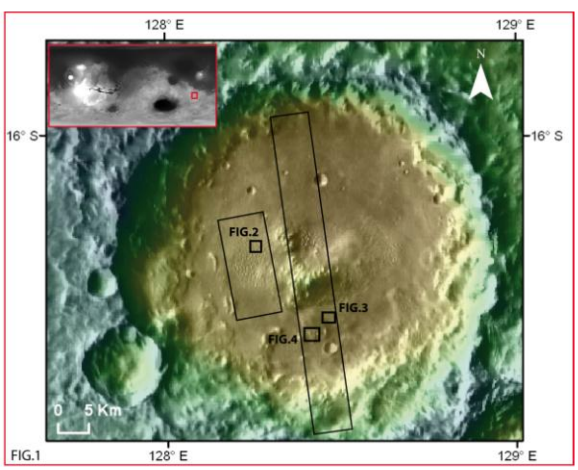

Fig. 1: A crater inside Herschel Crater in which we performed our analysis over shaded MOLA topography and a THEMIS IR daytime image mosaic. Black footprints indicate positions of HiRISE images analyzed. The location map of the studied zone is shown in the upper left corner.

Methodology

THEMIS visible images provide a useful coverage of the analyzed zone and the necessary spatial resolutions to identify Aeolian morphologies. CTX and HiRISE datasets allow us to perform slip face orientations. All the datasets were processed using the ISIS software and then integrated into a Geographical Information System (GIS) project. We produced a geomorphological map of the crater highlighting Aeolian units.

Results

In the studied crater Large Dark Dune fields (LDDs), and Transverse Aeolian Ridges (TARs) [6][7] are visible all around the central peak. We classified the morphology of dark dunes using McKee 's Criteria [8]: from the analysis of the HiRISE dataset we identified two complex ergs [9] inside the crater. They consist of barchans and barchanoid dunes. We identified also star dunes, influenced by complex wind regime (Fig.2).

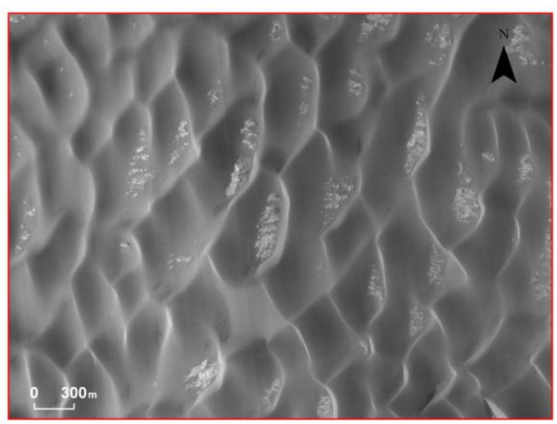

Fig. 2: A close up view of an erg. HiRISE image (PSP_003638_1635).

We found barchan dunes evolving into transverse dunes in response to a higher sediment supply as shown in Fig. 3.

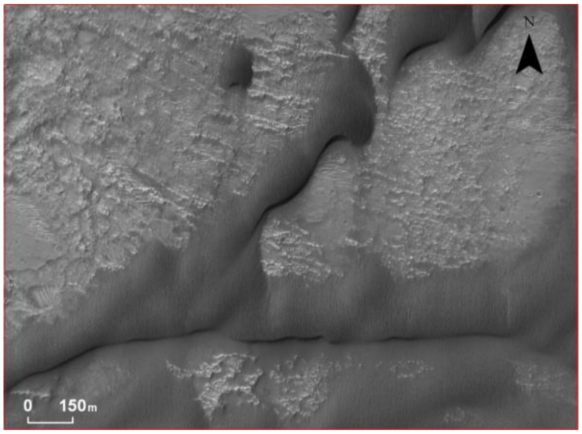

Fig. 3: Barchan dunes evolving into transverse dunes. HiRISE image (PSP_003638_1635).

A dominant wind direction from the north is responsible of the formation of the large dark dunes inside the crater. The central peak has influenced the main wind regime, leading to the development of secondary wind flows. Such flows also influence the morphology of bright bedforms (TARs) which have been classified according to the scheme of Wilson and Zimbelman [10]. Inside several craters we identified bright TARs preserving variable sets of crest orientations (Fig.4).

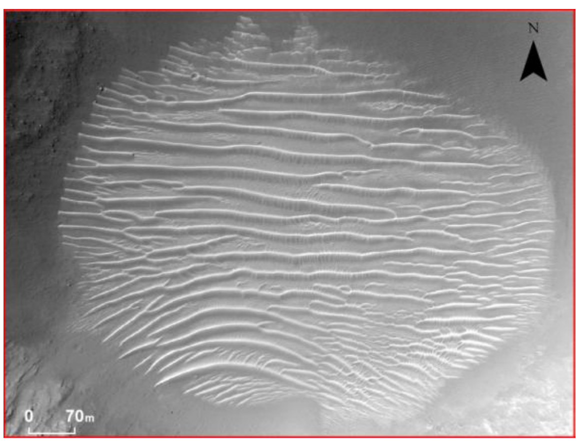

Fig.4: Diverse sets of TARS preserved inside the crater.

Considerations

Our study suggests that dark dunes have been formed by a main wind direction from the north and the central peak inside the crater influenced local wind flows forming complex ergs. Large dark dunes observed on top of bright bedforms represent the last episodes of Aeolian deposition. TARs, older than the dark dunes, also occur in different conditions, pristine and eroded [11]. We noticed that they appear with variable crest orientations, different wind flows of diverse ages may have formed them, and this may represent the early episodes of Aeolian deposition and erosion in the crater.

References

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