PRESENT-DAY AEOLIAN ACTIVITY IN ARABIA TERRA. FIRST RESULTS FROM A GLOBAL MAPPING OF ACTIVE DUNE FIELDS ON MARS.

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Introduction: It has long been unclear whether the many fields of sand dunes on Mars are actively evolving in the present climatic era. Although the occurrence of saltation elsewhere on contemporary Mars [1, 2, 3, 4, 5, 6] suggests that the potential exists to observe the migration of sand dunes and associated features, the possible activity of the many dunes outside of the polar regions remains largely unanalyzed. The aim of our work is to fill this gap, mapping dune activity between 65°N and 65°S (Fig. 1). In this report we present the preliminary results of this work: we mapped active dark ergs in the quadrangles MC-11 and MC-12 (Oxia Palus and Arabia Terra, respectively) (Fig. 1). This area, with several intra-crater dark dune fields and a good coverage of HiRISE images, represents an ideal site for the detection of signs of recent dune activity.

Methods: Data from the Mars Global Digital Dune Database (MGD^3) [7, 8] have been ingested into an ArcGIS environment in combination with the Martian global mosaics (MOC Wide Angle and the THEMIS Infrared daytime) to identify the dark ergs on a global scale. Then we used the footprints of the HiRISE camera in a shapefile format (http://ode.rsl.wustl.edu/mars/) to detect overlapping HiRISE images over the dark ergs. The images that present similar acquisition parameters (similar incidence and emission angles, seasons and time of acquisition) have been downloaded and analyzed in ArcGIS. Where noted, aeolian changes are categorized, as listed in Table 1.

Results: The results of this preliminary work are encouraging and are resumed in Fig. 2. Four sites in Arabia Terra present evidence of active sand saltation found on five pairs of overlapping HiRISE images (Table 1). All these sites consist of dark dune fields which show albedo variations likely caused by the removal of dark sand that saltates downwind (Fig. 3a). There is no evidence of significant amounts of dust that could otherwise explain such albedo variations. In Fig. 3b we highlight another kind of change over the stoss side of a barchanoid ridge (see inset for location) where one kind of bedform superposes another: 1) aeolian ripple (probably arranged in different sets like elsewhere on Mars [4] and 2) smaller secondary dunes (shadow dunes [9]) which develop in the lee of a bright rock emerging from the underlying bedrock. Those features display significant changes between T0 (11 April 2007, Ls=217.1°) and T1 (4 march 2009, Ls=220.6°). At T0 three distinct crests with a NW-SE trend are detectable, while at T1 the crest highlighted by the white arrow (Fig. 3b) is displaced toward the SW, where it joins the closer dune crest into a Y junction.

Discussion: These preliminary results suggest that sand saltation is a widespread process on the Martian surface and is not limited to few isolated cases. This is surprising as the average wind velocity predicted by atmospheric models [10] or in wind tunnel experiments simulating Martian conditions [11] is normally below the threshold for sand movement (one order of magnitude greater on Mars than on Earth [12]). For this reason, phenomena like turbulence and gustiness [11, 13] combined with the effect of hysteresis [14] should be considered in order to explain the observed aeolian changes.

Future work: When our database will be complete we will be able to reconstruct the wind regime responsible for the activity of the dunes. Then, with the aid of two kinds of atmospheric models on a global (GCM [15]) and local (MRAMS [16]) scale, the observed aeolian changes will be placed into an appropriate atmospheric context. Such models, particularly those run at high spatial resolution, will improve our understanding on how the local topography influences the Martian atmosphere and its role in influencing the present-day aeolian activity.

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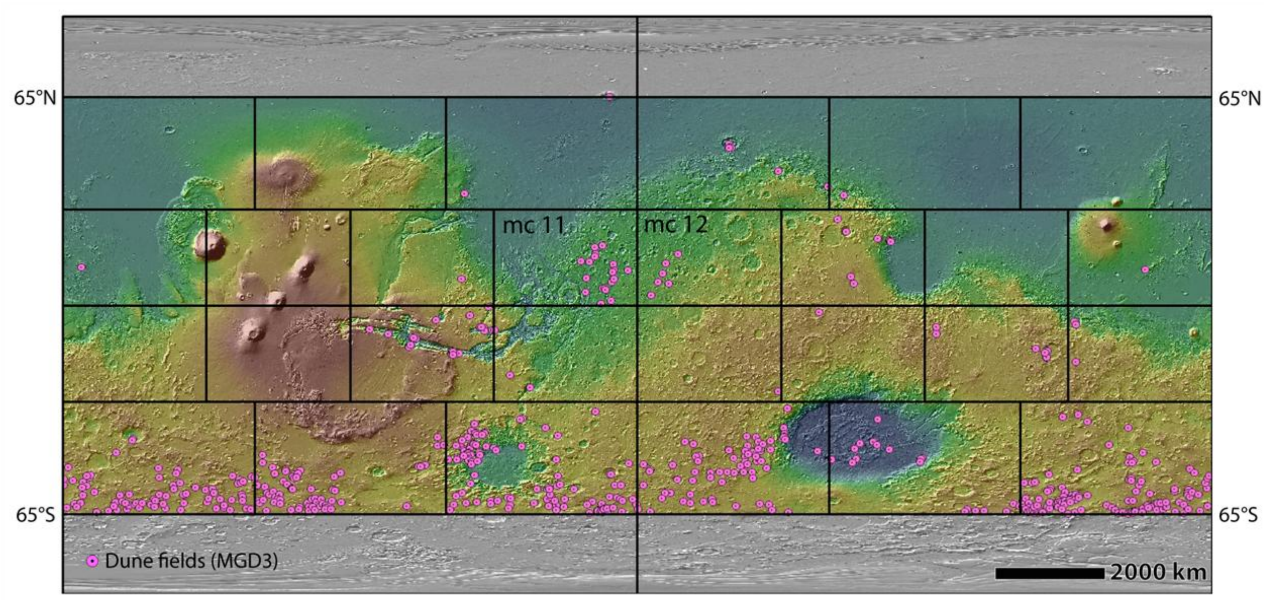

Fig. 1: Study area, MOLA colored shaded relief. Dune fields from the MGD[3] are shown in magenta.

Dune fields	Changes	Images id	Acquisition date	Ls
Arabia 1 (Becquerel)	Albedo variations	ESP_019268_2015 PSP_001546_2015	05 Sep 2010 24 Nov 2006	143.9° (Summer) 140.4° (Summer)
Arabia 2	Albedo variations	ESP_017580_1840 PSP_008798_1840 ESP_017224_1835 PSP_006860_1840	27 Apr 2010 12 Jun 2008 30 Mar 2010 12 Jan 2008	83.0° (Spring) 84.2° (Spring) 70.9° (Spring) 16.7° (Spring)
Arabia 3	Albedo variations Grainflow structures	ESP_016459_1830 PSP_007018_1830	29 Jan 2010 25 Jan 2008	44.7° (Spring) 22.5° (Spring)
Arabia 4	Albedo variations Grainflow structures Secondary dune changes Ripple changes?	ESP_012199_1810 PSP_003312_1810	04 Mar 2009 11 Apr 2007	220.6° (Autumn) 217.1° (Autumn)

Table 1: Aeolian changes in the study area.

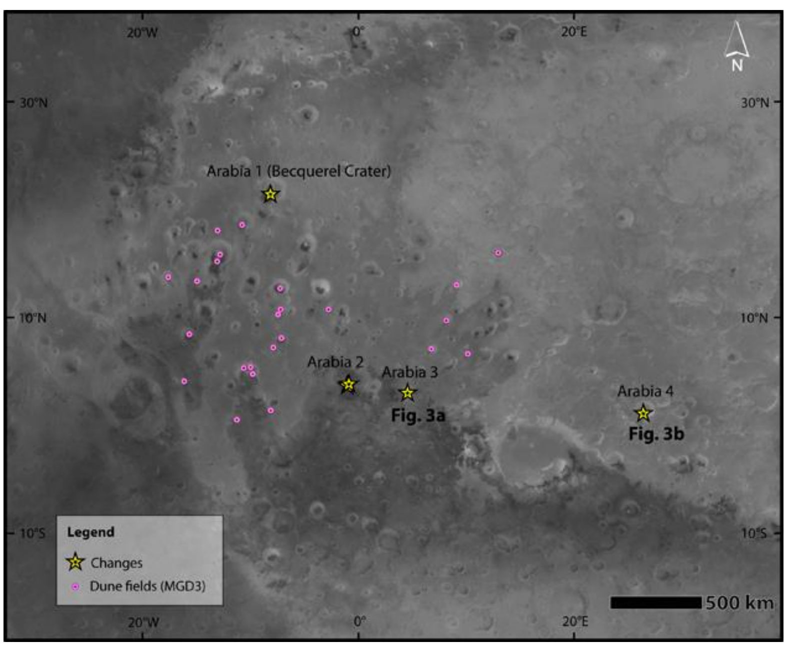

Fig. 2: Arabia Terra, location of the observed aeolian changes. MOC Wide Angle global mosaic.

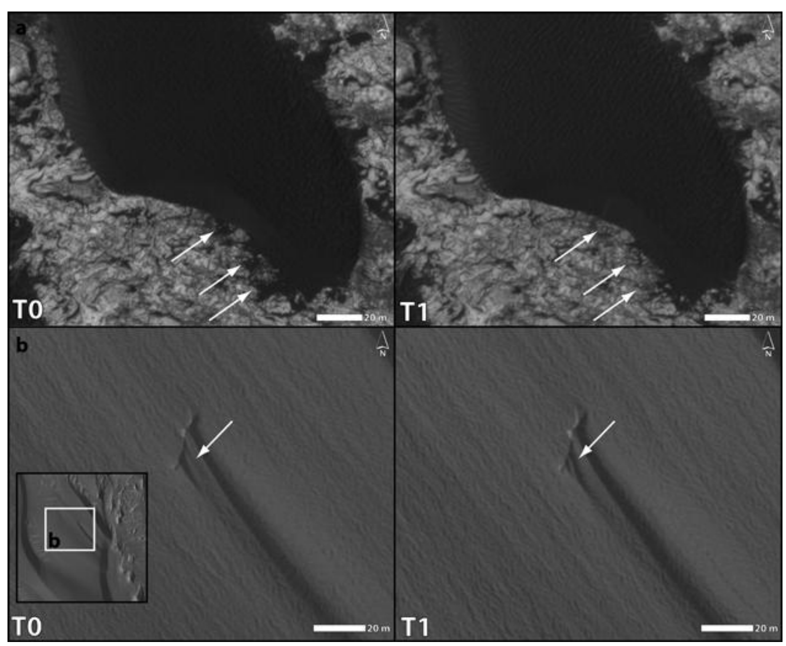

Fig. 3: Changes over the study dunes (white arrows), **a)** albedo variations **b)** "shadow dunes", formation of the Y junction at T1. HiRISE images ESP_016459_1830, PSP_007018_1830, ESP_012199_1810, PSP_003312_1810.