POTENTIAL MODEL FOR DARK ALBEDO FEATURES IN THE MARTIAN POLAR REGION OBSERVED AT 81°N 156°E.

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Introduction: Intriguing albedo features appear in the Martian polar regions during local spring, such as spider-like features[1], geysers [2], Dark Dune Spots (DDSs) [3,4] and streaks. For this abstract we have studied dark albedo features occurring at 81°N 156°E, see Figure 1, and we give a possible explanation for the process behind them.

Methods: We have studied images taken by the High Resolution Imaging Science Experiment (HiRISE) camera on the Mars Reconnaissance Orbiter (MRO). The camera operates at a resolution between 0.25 and 1.3 m/px [5,6].

The HiRISE images shown here all have a resolution of 0.25 m/px and are located at 81°N 156°E, in the Martian polar region; (PSP_006959_2610), (PSP_008185_2610), (PSP_008251_2610), (PSP_008396_2610), (PSP_009398_2610), with solar longitudes, L_s=20.4, 63.3, 65.6, 70.5 and 105 respectively, Martian Year 29 [6,7].

Observation: The first HiRISE image over the site at 81°N 156°E is taken in the early northern spring, at L_s=20.4, see Figure 1 & 2, and Figure 3 for a comparison of the streaks in Figure 2. It shows that dark features have begun to appear. Round, relatively large, dark spots are shown both on the flat ground and on the dune ridges. Around most spots there is one or more diffuse, fan-shaped areas directed away from the spots in many directions. The albedo of these areas is slightly brighter than the spots, but darker than the surrounding surface soil. There is also a polygonal pattern of thin lines, with small spots at some of the nodes, and fans in the wind direction originating from the nodes [8].

Later on, during local spring, at L_s=63.3, see Figure 4, there is an increase in the number of spots and the original spots visible earlier have at this point grown in size. The surrounding areas and fan-shaped features seem to have faded and been replaced by new diffuse areas. The polygonal patterns are narrower but more distinct than before. The most obvious change is the irregularly shaped, more confined streaks, extending from the spots on the dune ridges and running down the slopes. The streak features have the same albedo as the spots.

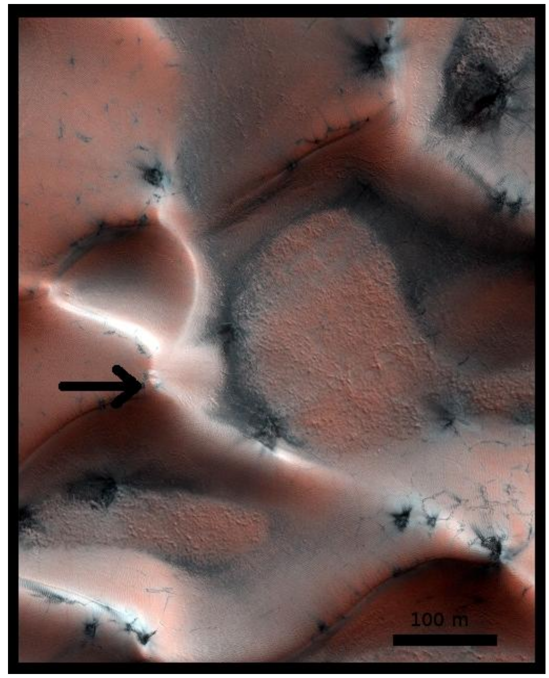

Figure 1: Martian dune field at 81N 156E, the observed site is indicated by the arrow, HiRISE image PSP_006959_2610 L_S=20.4. The image is non-mapped, north is at -8.8°.

Shortly after this, at L_s=65.6 the streaks have grown further in length and also in width. A small number of new spots have appeared. The diffuse areas around the spots have grown larger.

At L_s=70.5, the spots have grown larger and the streaks wider, but with only a small increase in length. A few streaks have grown radially at the end, creating a small pond, as has been shown by Kereszturi [9].

In the end of local spring, at L_s=105.0 (PSP_009398_2610), all the spots and dark albedo features are gone.

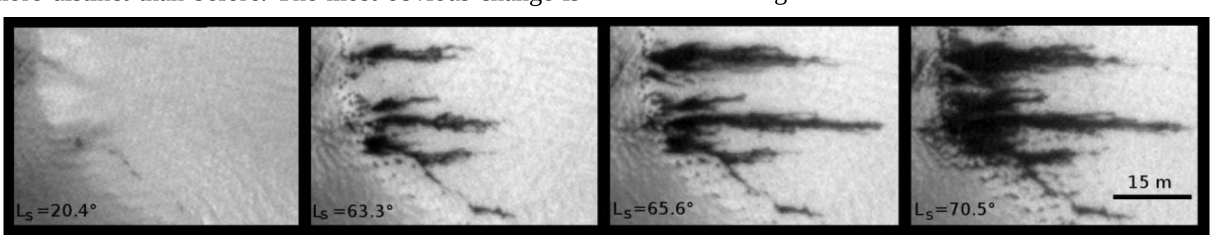

Figure 2: The images here show the area in the marked by the arrow in Figure 1 and show how the dark features changes with time. HiRISE images (PSP_006959_2610), (PSP_008185_2610), (PSP_008251_2610), and (PSP_008396_2610) respectively.

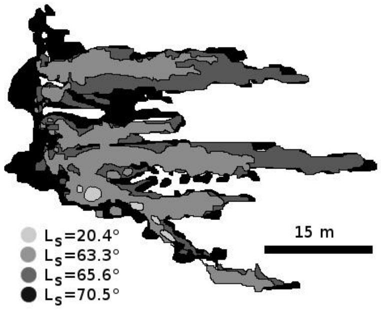

Figure 3: We contoured the spots and streaks on the images in Figure 2. The brightest is the earliest and the darkest is the most recent.

At other observed sites, such as the Richardson Crater [10] in the southern polar region 72°S 179°E, which has good time-lapse coverage, there is an area around the spots and streaks that are brighter then both the spots and the rest of the dunes. There is also a more diffuse, fan-shaped, bright area directed away from one or more sides of the spot.

Discussion: We hypothesize that these dark features are all based on roughly the same principle i.e. a solid state greenhouse effect. Their appearance are different due to different terrains in which they occur.

The dunes consist of dark soil and sometimes (depending on the composition of the respective dune) finer grained soil that is bright when dry, but dark when mixed with liquid water. Above that a layer of water ice, then CO_2 ice. At the surface there is a thin layer of bright, fine grained sand, which has been blown on top.

During local spring, the temperature rises and the dune receives direct sunlight. The CO_2 ice absorbs nearly none of the solar energy through direct absorption [11]. The water ice absorbs parts of the IR [12] spectrum, hence warming it. The darker soil underneath the ice absorbs most of the solar energy and heats up faster than the surroundings. The warmer soil also heats up the water ice just above, and a liquid interfacial water layer forms between the water ice and the soil. To some extent the soil will mix with the liquid. The ice eventually melts all the way to the surface, at first where the CO_2 ice layer is weakest, thus creating a

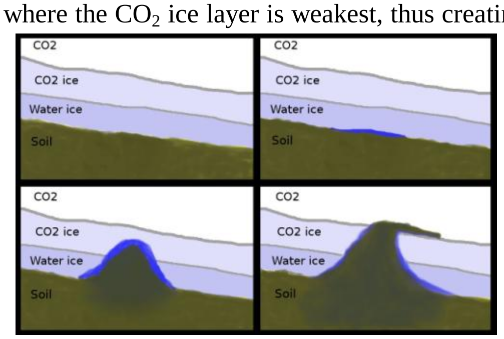

Figure 5: The sun warms up the soil and melts the water ice from below, creating a hole, and the soil seeps out and down the slope, creating the streak feature.

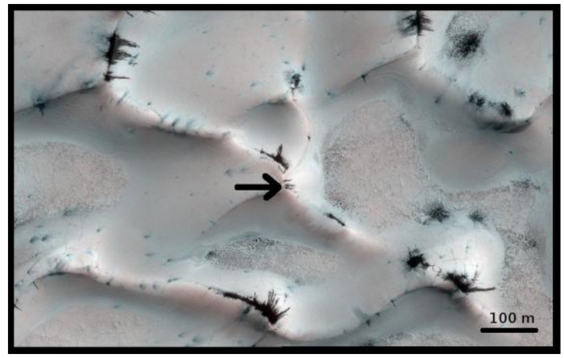

Figure 4: Martian dune field at 81N 156E, the observed site is indicated by the arrow, HiRISE image PSP_008185_2610, L_S=63.3. The image is non-mapped, north is at -5.6°.

hole. The soil-water mixture seeps out through the hole, carrying some of the dark dune material with it, thus creating the dark dune spot. This process will continue as the temperature rises and more ice melts and mixes with the soil.

For spots located on the dune slopes, the soil-water mixture seeps out through the hole and flows down the slope, creating the streak features. The streaks sometimes reach flat ground. When this happens, and with yet more soil-water mixture flowing out through the hole, the pond-like features appear at the end.

When the water in the soil-water mixture eventually evaporates, only the deposited soil remains. The wind catches part of the soil and spreads it out on the surrounding surface, creating diffuse bright areas around the spots as well as even more diffuse streaks directed away from the spots. The brighter grains, given their smaller size, are blown away in light winds. It takes strong winds for the darker, larger grains to be spread out. This selection of effects creates the bright and dark, diffuse, fan-shaped areas around the spots.

Due to the incomplete time coverage of the site at 81°N 156°E, there is no evidence of brighter areas occurring there, however it is possible that they appear later on. If not, this might be due to a different composition of the dune, with only dark soil.

Experiment: In order to test this hypothesis, an experimental simulation is being made, see Ramstad R. et al [13].

References: [1] Piquex S. et al. (2003) *JGR, 108*, 5084. [2] Kieffer H. H. et al. (2006) *Nature, 442*, 793-796. [3] Pócs T. et al. (2003) ESA SP-545, 265-266. [4] Horváth A. et al. (2001) *LPSC XXXII*, Abstract #1543. [5] McEwen A. S. et al. (2007), *JGR, 112*, E05S02. [6]http://hirise.lpl.arizona.edu. [7]http://www-mars.lmd.jussieu.fr/mars/time/martian_time.html. [8] Kereszturi A. et al. (2007) *LPSC, XXVIII*, Abstract #1864. [9]Kereszturi A. et al. (2009), *Icarus, 201*, 492-503. [10] Supulver K.D. et al. (2001), *LPSC XXXII*, Abstract #1966. [11] Hansen G.B. (2005) *JGR, 110*, E11003. [12] Grundy W.M. & Schmitt B. (1998) *JGR, 103*, 25, 809-822. [13] Ramstad R. et al. (2010), *LPSC XXXXI*, this meeting.