

MORPHOLOGICAL ANALYSIS OF ANNUAL RECURRENCE OF DARK DUNE SPOTS ON SOUTHERN POLAR REGION OF MARS.

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Abstract

Analysis of the Mars Global Surveyor narrow-angle images of the dark dune spots (DDSs) in three subsequent Martian winters and springs in Southern Polar Region resulted in the recognition that year by year DDSs reappeared on the same place with almost the same configuration. Comparison of the 1999 and 2001 high-resolution images showed a very interest recovery process.

Introduction

On Mars Global Surveyor MOC images taken in Martian winter and spring a peculiar spotting phenomenon was discovered on the dark dunes in the polar region of Mars [1]. These spots were named DDSs (Dark Dune Spots) and various hypotheses were put forward about their origin and formation process, which fall into two main groups: geophysical and biological [2, 3, and 4].

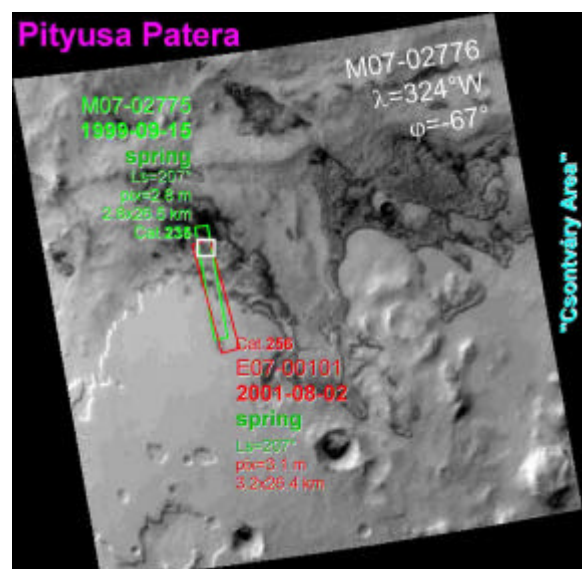


Fig. 1 The Pityusa Patera on the wide-angle context image of MGS. In this early spring image on the surface covered by the light colored frost the dark dune field can be distinguished by its darker gray tone. Green frame: image of 1999, Red frame: image of 2001, White frame: enlarged region shown on Fig. 2.

Our biogenic interpretation of the DDS origin, invoked the activity of putative Martian Surface Organisms (MSOs), provoked great debate and opposition, mainly among American planetologists.

It was possible to observe, on the early MGS images, the annual recurrence of the DDS phenomenon [5], and to determine that year to year the DDSs recover on the same place with almost the same configuration [4, 6]. But this early spring MOC-image of January, 1998 (AB1-07908) had low resolution (1 pixel = 16 meters), contrary to the high resolution of the 1999 November image (M09-03813) (1 pixel = 4

meters), therefore detailed morphological investigations were impossible. MOC images published on the Internet [7, 8], made in the southern winter and spring of 2001 about the vicinity of the Southern Polar region of Mars, opened up the possibility to analyze in detail the DDS recurrence in the latest MGS images.

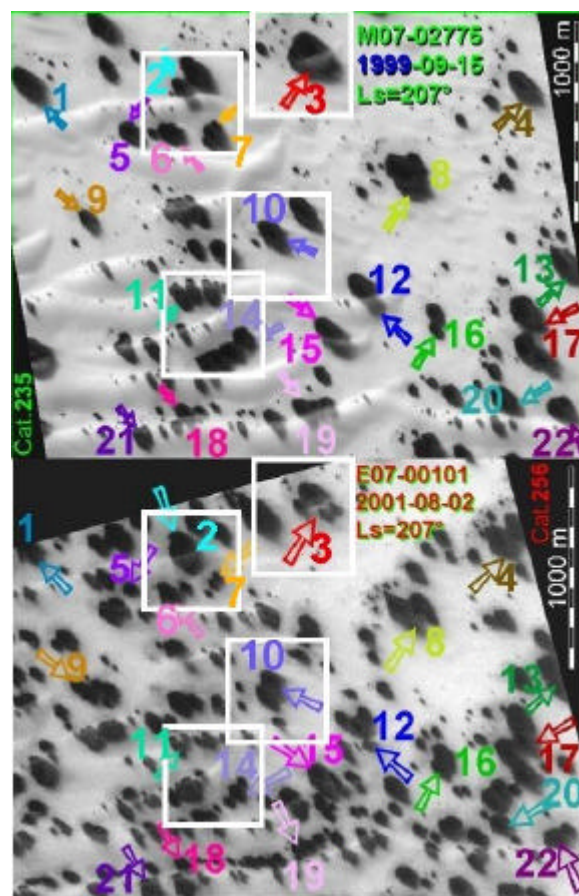


Fig. 2 Reappearing DDSs in the Pityusa Patera, first part of spring 1999 (upper) and 2001 (lower). The numbers with identical color show the identified DDS time-pairs (on identical geographical position). The images shown with white frames can be seen enlarged on Fig. 3.

Pityusa Patera

There is an excellent observation region for DDS phenomena in the Southern Polar region of Mars, in a territory with 200—250 km in diameter, at $\lambda = 324^\circ\text{W}$, $\phi = 67^\circ\text{S}$, west from the Malea Planum: the Pityusa Patera. On the Northern part of this patera there are large dune fields with 50—100 km size. (Fig. 1). During winter, spring and summer of the 1999 and 2001 terrestrial years the MGS MOC made more than a dozen high resolution images (Fig. 2) about the dune

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fields inside Pityusa Patera, which we call “Csontváry” area. The DDS phenomenon exhibits beautiful patterns on these winter and spring images (the DDSs are elongated and elliptical [2, 4] because the landscape on the images tilts towards the South). The MGS space probe made two high-resolution images (1 pixel = 2.8-3.1 m, M07-02775 and E07-00101) about the appearance of the DDSs, which have identical Martian seasonal phase ($L_s=207^\circ$), located in almost identical geographical territory (Fig. 1, 2).

Annual recurrence in 2001

In this study we compare the annual reappearance of the DDSs in identical geographical areas of these two figures

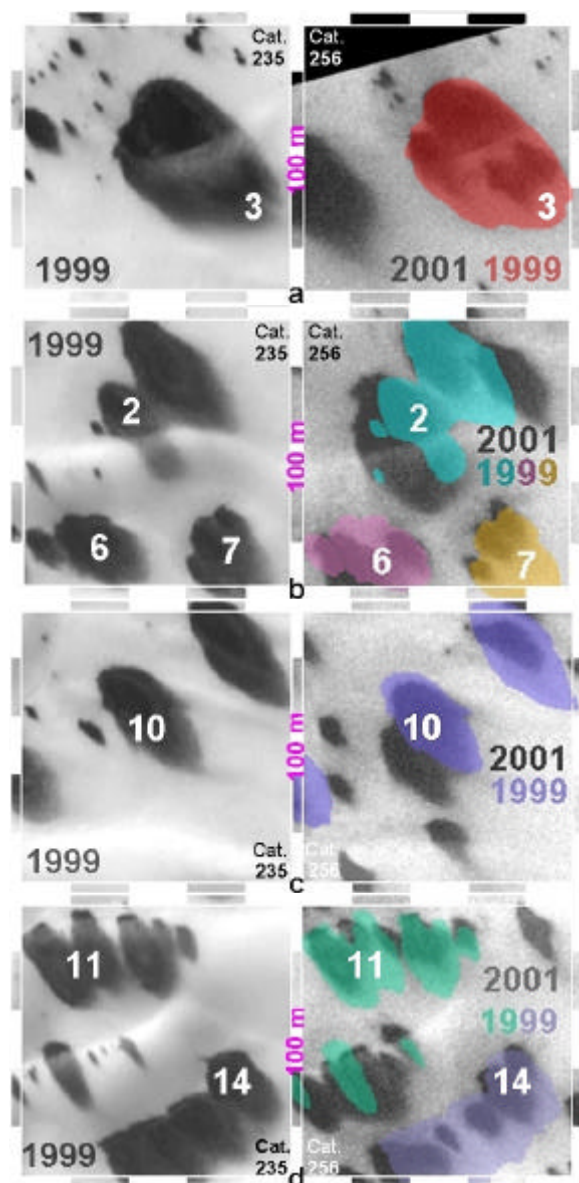


Fig. 3 Comparison of reappearing DDS time-pairs from the 1999 and 2001 MOC images; enlarged white frame areas from Fig. 2 (500x500 meters). The DDSs of 1999 (shown on left images) are also shown with transparent color on the right images of 2001.

(see the white frames on Fig.1) and draw the first conclusions (Fig. 2).

On both parts of the images (2x3 km) we marked with identical color and number those DDSs (with at least 100 meters in size), which appear at identical geographical sites. The identification of the geographical sites was accomplished on the basis of the morphological relief of the dunes. Some detailed comparisons of characteristic time-pairs of recovering DDSs of Fig. 2 are shown enlarged in Fig. 3a-d.

On Fig. 3a right, the recovering large DDS pattern appears in identical position, but with a slightly diminished surrounding gray area, and to the left from it a new, big DDS appeared. On Fig. 3b right, three large DDS groups appear. We can observe a little difference in the later groups in size. The group No. 2 is larger in 2001; the group No. 7 is smaller in 2001, as compared to the respective time-pairs in 1999.

On Fig. 3c right, there are three great recovering DDSs. The upper right and lower left DDSs are smaller in 2001, while the middle (No. 10) DDS is doubled in 2001 as compared to their time-pairs in 1999. On Fig. 3d we can observe three parallel sequence patterns of DDSs. The upper and lower recovering rows are smaller in 2001, while the middle sequence of DDSs is larger in 2001, as compared with the corresponding time-pairs in 1999.

Degree of reappearance

We calculated the percentage of the reappearing DDSs of 2001 relative to the data of DDSs in 1999 of Fig. 2. The number of the old spots *reappearing* (in regenerated form) is 69% of the whole DDS population of 2001. The number of the *new spots*, not present on the earlier images (1999), is 26% of the total. The number of DDSs *not recovering* is 5% of the all the DDSs.

Conclusions

Annual reappearance was observed earlier [4, 5, 6], but only the latest MOC images have made it possible to numerically estimate the degree of DDS recurrence. Our statistical estimation shows that the majority of the DDSs are recovering on the same site (time-pairs), while a smaller percent disappears or seems to be generated *de novo*. The dynamics of the reappearance may depend on local meteorological conditions. The massive reappearance of the spots at their original sites seems to be compatible with our MSO hypothesis [2] about the biological origin of DDSs.

Acknowledgments: Authors thank for the use of MGS MOC images of NASA JPL and Malin Space Science Systems [7, 8].

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