PROBABLE EVIDENCES OF RECENT BIOLOGICAL ACTIVITY ON MARS: APPEARANCE AND GROWING OF DARK DUNE SPOTS IN THE SOUTH POLAR REGION. *A. Horváth[1,3], T. Gánti[2], A. Gesztesi[3], Sz. Bérczi[4], E. Szathmáry[2],* [1]Konkoly Observatory, P. O. Box 67, Budapest H-1525, Hungary, [2]Collegium Budapest, Institute for Advanced Study, H-1014 Budapest, Szentháromság tér 2. Hungary, [3]Budapest Planetarium, H-1476 Budapest, P. O. Box. 47, Hungary, [4]Eötvös University, Dept. G. Physics, Cosmic Mat. Sp. Res. Gr. H-1117 Budapest, Pázmány P. s. 1/a. Hungary, (szathmary@zeus.colbud.hu)

Abstract: Morphological analysis of dark dune spots (DDSs) on the intracrater dark sand sheets in the southern polar region of Mars has led to a surprising conclusion. The most recently suggested process of frost sublimation is not compatible with a few important features we have observed by detailed analysis of a series images of Mars Global Surveyor (MGS). These features include the presence of individual spots which does not fit to the surface topography, and a number of obvious water streams flowing out from these spots. We speculate that sublimation process should be combined with some kind of biological activity and it is of prime importance to be checked by the next landers.

Introduction: MGS Mars Orbiter Camera (MOC) images of 1998 and 1999 showed interesting features on the dark dune fields in the south polar regions of Mars. These DDSs and their cluster could be observed during late winter and early spring [1]. It is well known that these dunes are the first surfaces to frost in the fall and defrost during late winter and early spring, still frost may well persist on them until late spring or even early summer [2]. Edgett et al. [3] have made an analysis of the whole defrosting process from the winter until the summer of the southern hemisphere, using images taken in 1999-2000 of the low-albedo dune fields. They concluded that a complex process of CO_2 and H_2O sublimation and reprecipitation occurs as function of season and local temperature, which is controlled by the surface and interior physical properties of the dunes [2] and [3].

Observations/Discussion: We have analyzed more than a hundred MGS MOC images, preprocessed and published on the World Wide Web by the Malin Space Science Systems. As the two polar regions of the Mars are quite different from each other [4], the southern polar region was chosen for the primary morphological analysis of the DDSs. MOC red wide-angle context images (wavelength 600-630 nanometers) helped orientation, while MOC narrow-angle images (wavelength 500-900 nanometers) were used for detailed analysis of the DDS. The narrow-angle images usually cover a 1--3 km wide and 20--80 km long area, with a high, 3--8 m/pixel resolution. After enlargement and identification of interesting areas, the contrast and brightness of the images were improved using Paint Shop Pro 6 software. These modifications only served to emphasize the information on the images.

The analyzed MGS MOC narrow-angle images were taken between June 1999 and February 2000 (from late winter to early summer of the southern hemisphere), and cover areas between 65°S--71°S latitudes. In all of these images nearly circular dark dune spots and their cluster can be seen. The diameter of these DDSs varies between a few dozen and a few hundred meters and have an interesting inner ring-structure, which can be seen only in the highest resolution images (Figs. 1A—1D).

An interesting new observation is the relationship between the fine-scale topography and the circular extent of the individual DDSs on top of the dune sheets. Figure 2 illustrates the general situation that the whereabouts and the shape of the individual DDSs are practically independent of the fine-scale local topographic variation. In other words, it looks like if DDSs grew radial rather then follow fine-scale topographic highs or lows. There is another, even more stimulating, new observation that DDSs are not restricted to a single and favored topographic level.

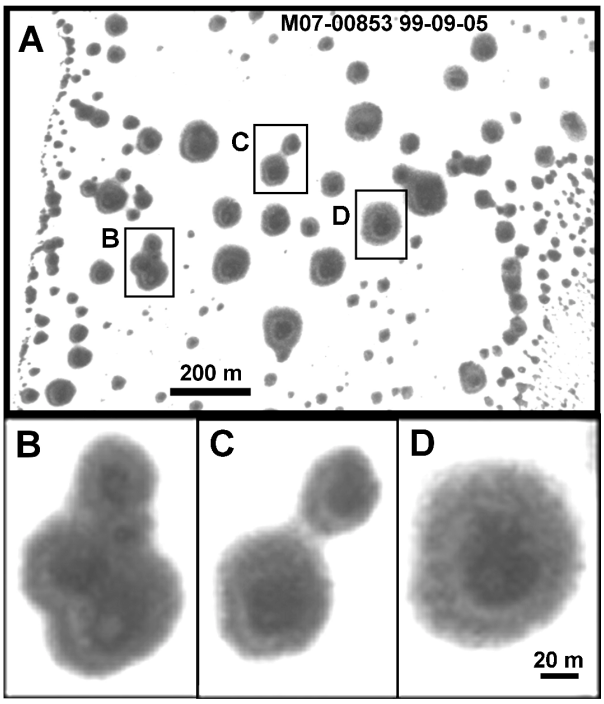

Figure 1. On sufficiently high-resolution images a lighter ring is apparent between the dark core and the gray zone of the DDSs. Presumably, this is due to the re-frosting of the water vapor arising from the dark core. The process is facilitated by the cooling effect of the fast evaporation of water leaking out from below the ice. On the Figure 1A is a dune sheet inside a 50-km-wide crater located near 65°S, 15°W, Ls=201°. Figure 1B—1D are the individual spots with ring-structures.

During springtime the originally circular DDSs apparently "flow apart" characteristically downslope from the crest of the dunes, such resulting in a surprisingly parallel pattern of "flow-lines" (Fig. 3A). Therefore we believe that the formation of these features is associated with to the appearance of the liquid phase, most probably water. Fig. 3 shows a spectacular example of elongated dark spots in the Lyell Crater. The presence of liquid phase and surface waters flow is supported by Figure. 3B. The image shows DDSs that are

PROBABLE RECENT BIOLOGICAL ACTIVITY ON MARS: CHANGING SOUTH POLAR DARK DUNE SPOTS.

A. Horváth, T. Gánti, A. Gesztesi, Sz. Bérczi, E. Szathmáry.

not only elongated but are arranged in several hundred meter long, winding stripes, which are most probably tracks of water flows. At other sites Malin and Edgett have already found overwhelming evidence for recent groundwater seepage and surface runoff on Mars [5].

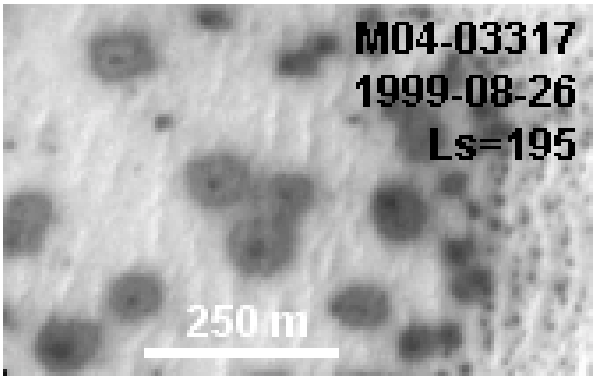

Figure 2. Image to show circular shape DDSs overprinting on the fine-scale topographic variations. This figure is a subframe of MOC image M04-03317 from the dune field of the Jeans Crater. Sun illuminated from upper left and north is approximately up.

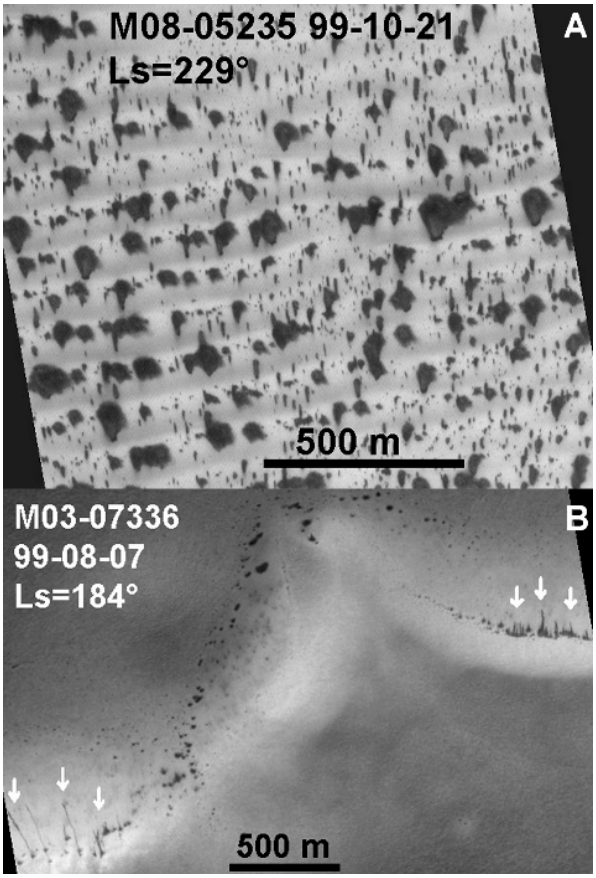

Figure 3. Elongated dark dune spots and water flowing on the slopes of the dune fields of Lyell Crater located near 70°S, 15°W. On Figure 3A the elongated shape of the DDSs may be a sign of liquid flow in mid-spring and on the Figure 3B traces of water flowing (arrows) out from the dark spots during early spring. Sun illuminated from upper left and north is approximately up.

Biological interpretation: From the above observations we conclude that even a complex sublimation process is insufficient to explain the formation and evolution of the DDS in space and time. A new key player is required and it might be a form of primitive life activity.

If life indeed exists on Mars then it must have adapted to the conditions and to the changes thereof. It follows that photoautotrophic Martian Surface Organisms (MSOs) must have evolved pigments with high absorbency. We suggest they conduct the following life-cycle. During the winter the soil below the spots is deep-frozen and some form of ice/frost covers them. MSOs must occupy a layer between the soil surface and the ice sheet. Because ice is transparent to light, MSOs intensely absorb the emerging sunlight and thus warm up at the end of the winter. From a frozen state they pass to a molten one, which also applies to part of the ice around them. Thus MSOs find themselves in a liquid solute, in contact with the underlying soil, enabling them to take up the necessary nutrients. The volume and extension of the liquid region increase with the intensity of the insolation.

The ice cover above the forming liquid water provides excellent heat insulation and prevents fast evaporation that otherwise would be inescapable due to the low atmospheric pressure. The fact that the spots mainly appear in the polar region indicates that a long period of sunlight is a necessary condition for their formation, since it prevents night frosting of water around the MSOs. The closest known analog is a mid-ice photosynthetic bacterial consortium in Antarctica [6].

Landing site proposal: The planned NASA second rover mission on Mars will take place between the end of January and April 2004. During this period, on the southern polar region the season changes from winter (Ls ≈ 135°) to spring (Ls ≈ 180°), which is the onset of DDSs formation. In order to test this fascinating possibility of life on the planet Mars our proposal is a landing site for this mission between latitudes 65°S –70°S, near to the edge of the dark dune sheet which a promising DDSs site inside a crater.

Acknowledgments: The authors acknowledge the use of Mars Orbiter Camera images processed by Malin Space Science Systems, and we also acknowledge valuable discussions with J. Maynard Smith, G. von Kiedrowski, I. Almár, L. Balázs, I. Fejes, F. Horváth, and E. Illés-Almár.

References: [1] Malin M. C. and Edgett K. S. (2000): *LPSC XXXI*, #1052. [2] Malin M. C. and Edgett K. S. (2000): *LPSC XXXI*, #1056. [3]. Edgett K. S and Malin M. C. (1999): *LPSC XXX*, #1029. [4]. Malin M. C. and Edgett K. S (2000): *Mars Polar Science and Exploration Conference II*, #4042. [5] Malin M. C. and Edgett K. S. (2000): *Science*, **288**, 2330-2335. [6] J. C. Priscu (1998): *Science* **280,** 2095-2098.