THE "INCA CITY" REGION OF MARS: TESTFIELD FOR DARK DUNE SPOTS ORIGIN. *A. Horváth* [1,2], *Sz. Bérczi* [3], *T. Gánti* [4], *A. Gesztesi* [1], *E. Szathmáry* [4,5] [1]Budapest Planetarium, H-1476 Budapest Pf. 47, Hungary, [2]Konkoly Observatory, H-1525 Budapest Pf. 67, Hungary, [3]Eötvös University, Dept. G. Physics, Cosmic Mat. Sp. Res. Gr. H-1117 Budapest, Pázmány 1/a. Hungary, [4]Collegium Budapest (Institute for Advanced Study), 2 Szentháromság, H-1014 Budapest, Hungary, [5]Eötvös University, Dept. of Plant Taxonomy and Ecology, H-1117 Budapest, Pázmány 1/a. Hungary (planet@mail.datanet.hu)

Abstract: We analyzed the *Dark Dune Spots (DDSs)* in the "Inca City" Region from more than 60 MGS MOC images. On high-resolution MOC images we followed the shape, pattern changes, fading and reappearance of these spots. The morphological changes support biological+physical over geological+physical interpretations of the DDSs.

Introduction: The discovery of dark dune spots on Mars, on the MGS MOC narrow angle images [1], prompted great debate on the origin of these spots. We proposed biological type processes [2, 3], whereas others suggested geophysical explanations [4].

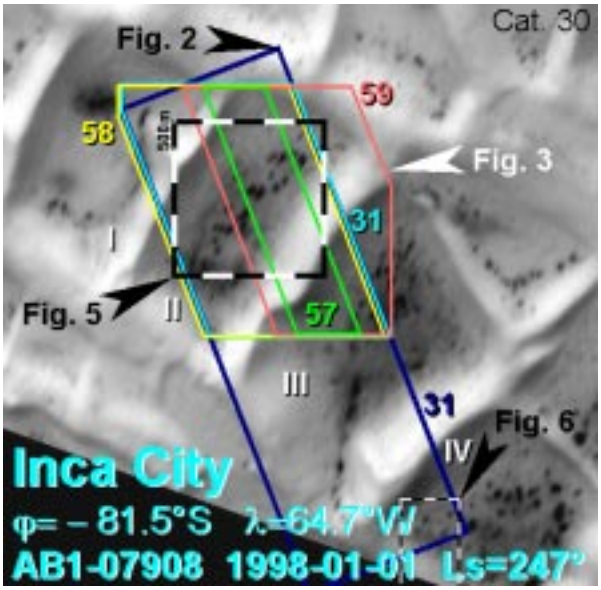

Figure 1 Typical circular dark dune spots (DDSs) on DD fields late spring of the southern polar "Inca City" region of Mars in 1998. Sun illuminated from upper left and north is up. We marked the localities of the later images by frames. Colored numbers refer to our DDS catalogue (Cat.): these numbers are given in the corners of all images; Roman numerals refer to "cassettes".

MGS MOC materials: Pre-processed images of the Malin Space Science Systems (http://www.msss.com/moc_gallery/) were analyzed from the years 1999 to 2001, from winter to summer of the southern hemisphere.

Time sequence of individual DDS defrosting: The rectilinear ridged landform known from Mariner 9 images, as bearing the informal name „Inca City", is located at 81.5° S, 64.7° W. The floor and ridges are composed of *dark dune (DD)* materials. During defrosting of the ice-cover DDSs appear in winter in the "Inca City's cassettes" as ephemeral objects (Figs 1, 2). The DDSs follow a characteristic defrosting time pattern, which is summarized in Figs 3, 4.

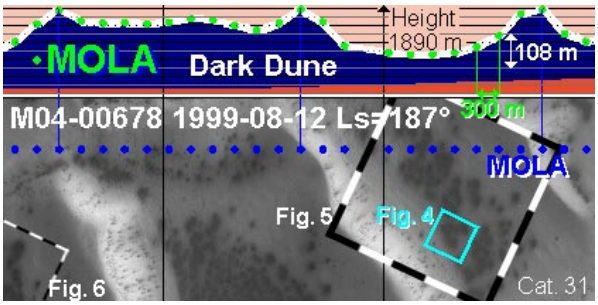

Figure 2 The depth and width of dark dunes in the "Inca City" region. Our model cross-section was obtained by using of the MGS MOLA laser height-measurements data. The height of the dune hills in these "cassettes" alternates between 70-220 meters. In the lower image Sun illuminated from upper right and north is right down.

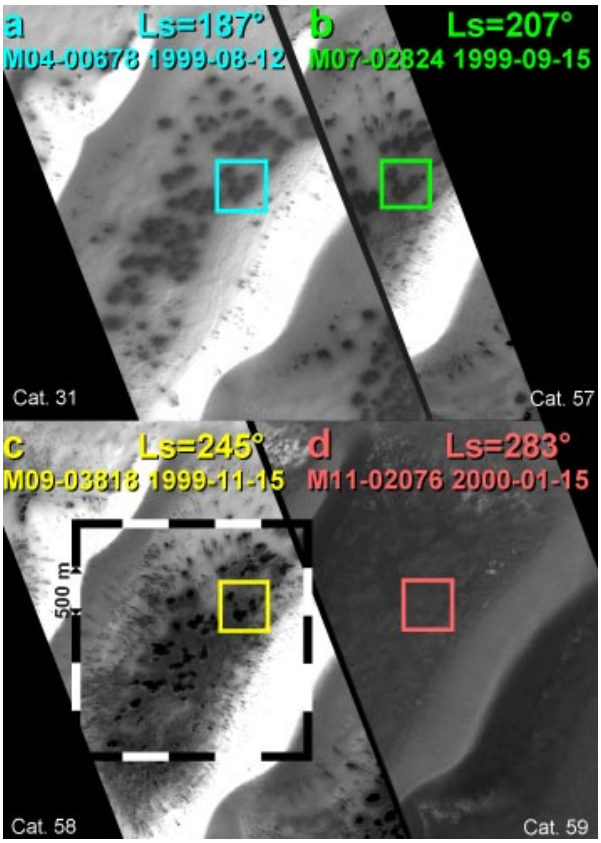

Figure 3 On these images we can observe seasonal changes of DDSs on the frosted and defrosted dark dunes of the „Inca City" from early spring till early summer. (a) Early spring gray fuzzy spots appear on the frost. (b) In the middle of the first half of spring from the gray spots bounded spots with expressed margin develop. (c) By the end of spring the inner region of DDSs turns black. (d) By early summer defrosting is completed in this region and we can see the naked dark soil of the dune. Sun illuminated from upper left and north is approximately at the top in all these MGS MOC narrow angle images. Color framed regions are enlarged in Fig. 4. and black-and-white refers to Fig. 5.

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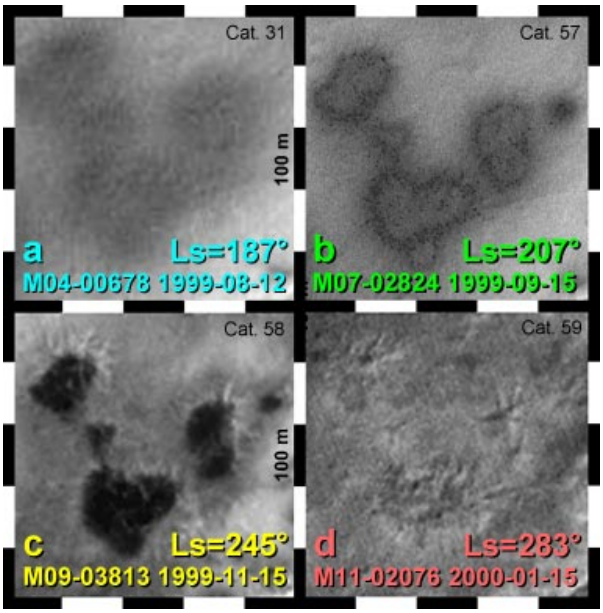

Figure 4 Stages of DDS development from spring till summer on the enlarged II. Cassette regions of Fig. 3. (**a**) Beginning of spring gray fuzzy spots appear (the process begins in the bottom of the ice cover). (**b**) Middle spring bounded gray spots develop. (**c**) Late spring inner regions become dark surrounded by a lighter ring. (**d**) Till summer the frost disappears in DD and we can see the naked dark sand and lighter rings with darker central portions mark the localities of DDSs.

Time sequence of patterns of multiple DDS defrosting: Several years of MGS imaging resulted in the recognition that year by year DDSs "renew" on the same place with almost the same configuration or "constellation" (**Fig. 5**).

Another collective phenomenon of DDS-pattern is that the spring "constellation" of DDS appears as summer "constellation" of *light gray patches (LGP)* on the DD fields (**Fig. 6**). This repeated occurrence of the DDS and LGP "constellation" of spots strengthens our suggestion of fixed – biological– causes of spot formation. This temporal phenomenon is a seasonal pattern of DDSs "constellation".

We summarize observed changes of DDS in **Table 1**.

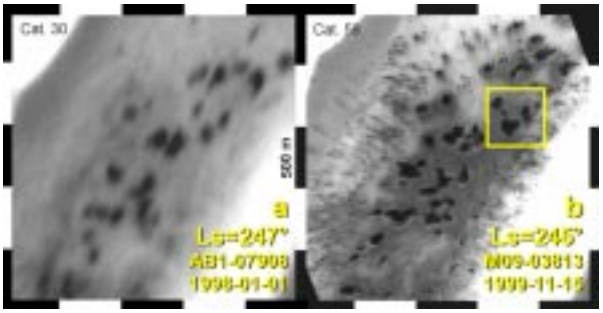

Figure 5 Year by year the DDSs appear almost at the same place with the same configuration in the "Inca City" (**a** is from images of Figs 1 and **b** is from Fig. 3c). The occurrence of DDSs patterns in the same place with the same "constellation" of spots suggests that the cause of their appearance is fixed on the surface of the DD fields. This temporal phenomenon is an annual pattern of DDS "constellation" of one year to DDS "constellation" to the next one. Sun illuminated from upper left and north is up. Enlarged yellow frame see on Fig. 4c.

Table 1 Growing individual **DDS**s	Changing pattern of multiple DDSs
Appearance of *fuzzy gray coloring* on the white frosted field. Later *dark dune spots* begin to *appear from bottom* of the ice cover.	No DDSs; only *gray field* regions and rarely single gray spots. Later *many* DDSs appear on gray field, mainly *at* DD field *edges.*
A DDS *structure begins* to appear, with inner/outer "umbra/penumbra".	Multiple appearances of DDSs on the frosted field with inner structures.
Gradually *enlarging DDSs; ellipsoidal DDSs* extend in slope direction	*Coalescence* of individual DDSs at outer boundaries.
Coalescence of DDSs; occasionally *flow elements appear* (tail) in the direction of the slope.	*Multiple flow patterns* exhibit the direction of *down slope* on the dark dune field.
On DD surface a *lighter spot* remnant appears; it seems to preserve the "*imprint*" of place of the spot where defrosting originally began.	Frost-free dry DD surface preserves *multiple "imprints"* on places where the defrosting originally began with individual spots.

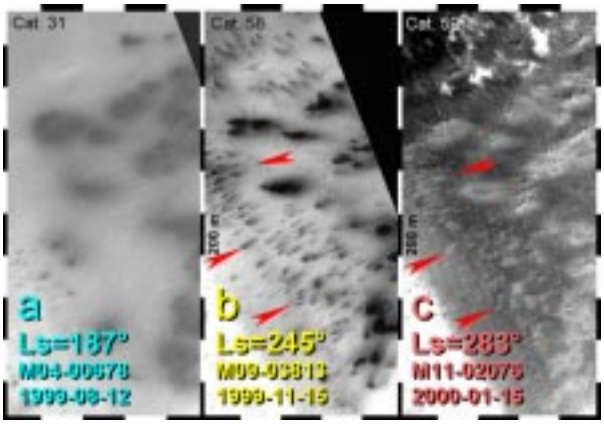

Figure 6 Spring "constellation" of DDS (**a**, **b**) appears as summer "constellation" of light gray patches (LGP) on the DD fields of "Inca City" (**c**). Dark tails of **b** can be seen as light gray tails on **c** (arrows).

DDS-MSO hypothesis proposes biological interpretation: We interpreted the sequence of DDS formation and changes as a result of activity of a kind of probable Martian Surface Organisms (MSOs). They survive below the surface ice, sunlight heats up them and they generate their living conditions. [2, 3, **5, 6**]. Interpretations are given in **Table 2**.:

Table 2 **Biological** reasons	Geological + physical reasons
Defrosting, shapes/places of DDSs are triggered by **MSOs life activity**. Defrosting **begins from bottom** of frosted layer (therefore **DDSs are holes** in the frost layer). Multiple DDS-pattern: position of spots is determined by constant places of MSOs. Gravity-assisted **seepage** of brine transport, respectively soil grains help extension of MSOs along slopes. On defrosted places: **MSOs desiccate** (LGPs: are MSOs remnants).	*Sublimation* causes defrosting on geologically preferred places. Almost circular shape of DDSs is formed by *upstream convection*. Flow of some brines on the slopes due to geographical reasons, gravity-assisted seepage. There is a transitional region ("penumbra") between defrosted and desiccated central dark spots ("umbra") and the light colored precipitation frost covered surfaces.

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References: [1] Malin M. & Edgett K. (2000) *LPSC XXXI*, #1052. [2] Horváth A., Gánti T., Gesztesi A., Bérczi Sz., Szathmáry E. (2001a) *LPS XXXII*, #1543. [3] Horváth A. at al. (2001b) in *Proc. RAS*, in print. [4] Malin M. & Edgett K. (2001) J. Geophys. Res. ***106***, E10, p. 23429. [5] Horváth A., Gánti T., Gesztesi A., Bérczi Sz., Szathmáry E. (2002a) *LPS XXXIII*, #1108. [6], Gánti T. at al. (2002) *LPS XXXIII*, #1221. [7] NASA, JPL, Planetary Image Atlas Website.