USE OF ORBITAL MISSIONS TO DETECT TRACES OF LIFE OR FAVOURABLE HABITATS ON MARS

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ABSTRACT

The remote sensing possibilities of orbiters together with their global mapping possibilities allow them to search for an inventory of characteristics of a life habitat on Mars, they permit also a systematic search for the gases that could be indicative of life episodes as well as favourable radiation environments. The current missions are reviewed versus their capability for this objective and ideas are proposed for a specific astrobiology Mars orbiter. Orbiters combine global mapping with the satisfaction of contamination requirements. The recent mapping of dark dune spots and underground ice deposits as well as previous unverified enhancements in atmospheric composition shows possible ways to use orbiters in life detection.

INTRODUCTION: LIFE TRACES IN MARS ATMOSPHERE.

The Martian atmosphere consists mainly of carbon dioxide *(95.32 %)* with trace quantities of N_2 *(2.7 %)*, *Ar (1.5 %)*, O_2 *(0.13 %)*, CO *(0.07 %)* and less abundant species. However, minor constituents have been very rarely studied because of the difficulty of putting on Martian spacecrafts the complement of instruments now used in earth observations.
Additional trace species are important in understanding the behaviour of atmospheric and surface oxidants that have been usually accepted as making the Martian environment sterile. These are ozone and the water vapour which are good indicators of the odd hydrogen species (*H, OH, HO_2*). Also, organic molecules should be searched for in the long term. For example, in 1989, the PHOBOS mission in orbit around the planet Mars observed a few limb infrared occultation spectra before spacecraft failure. The instrument was the infrared Russian channel of the Franco-Russian AUGUSTE limb sounder. The spectra surprisingly showed two peaks, which until now can only be identified as formaldehyde, a 1969 telescopic spectrum obtained by JPL was also then interpreted as containing a formaldehyde structure. (Korablev et al, 1993).

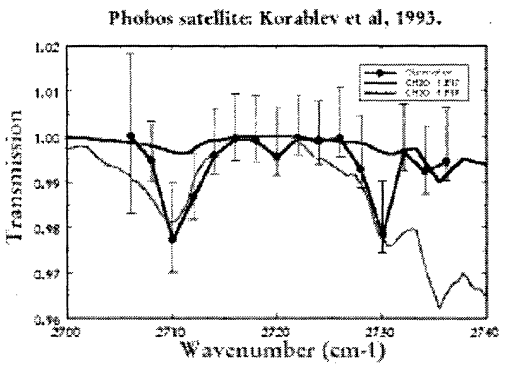

Fig.1: Observation of formaldehyde from the PHOBOS mission in 1989, the error bars correspond to several limb occultation observations around a grazing altitude of 20 km. (Korablev et al, 1993). In the absence of rain, formaldehyde would accumulate in large quantities in the earth's atmosphere but its presence in the Martian atmosphere without the sure detection of a methane source is still unexplained.

The IASB-BIRA MARS-2D photochemical model (e.g. Moreau *et al.*, 1991, Moreau and Fonteyn, 1998) is a model treating interactively radiative, dynamical and chemical processes in two dimensions. However, it never could reproduce the values deduced from the Phobos observations except by introducing bacterial

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activity that could be enhanced by hypothetical geothermal events.

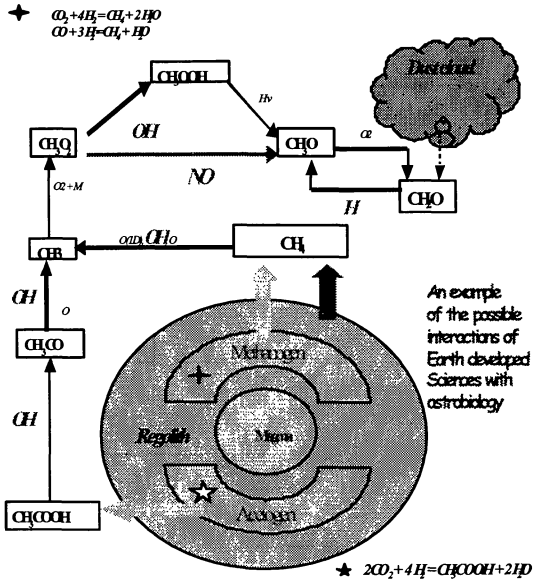

Fig. 2. : Diagram of a possible mechanism of transfer of organically produced endolithic gases to the Martian atmosphere. (Moreau, 1995, Moreau and Fonteyn, 1999)

PRESENT MISSIONS

The present Mars orbiters MGS and Mars Odyssei carry already some exobiology objectives by geomorphology implications and the "follow the water" strategy characteristic of the "Mars Odyssei" payload.

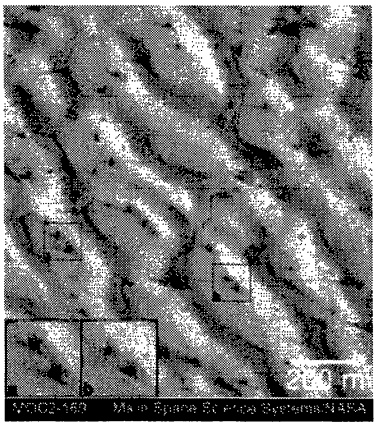

Fig. 3. : dark dune spots seen by MGS, these features have been interpreted by Horvath et al (2002) as having a possible biological origin.

FUTURE MISSIONS

The current Mars-Express payload has some life related environment capability in the SPICAM (Muller et al, 2001) and PFS instruments but unfortunately the observation of the organic balance is not present on the payload. A dedicated life search orbiter is still to be designed and would require a much longer description than the format of this paper. Its main instrument would be an hyperspectral surface imager able to analyse the composition of coloured terrains and a high spectral resolution atmospheric sounder able to observe variations of gases near the surface including products of biological activity, the with a capability in the CH bands ranging from 2 to 4 µm. This type of payload can be designed in parallel to the new spectacular developments of small environmental monitoring satellites currently under testing in earth sciences programmes.

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REFERENCES

Horvath, A. ,Berzi, Sz, Ganti, T.,Gesztesi, A. and Szathmari, E., 2002. The Inca city region of Mars: Testfield for dark dune spots origin, Lunar and planetary sciences XXXIII, paper 1109, Lunar and Planetary Sciences Institute, Houston.

Korablev, O.I., Ackerman, M., Krasnopolsky, V.A., Moroz, V.I., Muller, C., Rodin, A.V. and Atreya, S.K, .1993 Tentative identification of formaldehyde in the Martian atmosphere, Planet. Space Sci, **41**, 441-451.

Moreau, D., L.W. Esposito, and G. Brasseur, 1991. The chemical composition of the dust-free Martian atmosphere: preliminary results of a two-dimensional model, J.G.R., 96, 7933-7945

Moreau, D., 1995, Aéronomie de la basse et moyenne atmosphère martienne, Thèse, Université Libre de Bruxelles.

Moreau, D. and Fonteyn, D., 1999, Two-dimensional study of the atmospheric and surface oxidants on Mars, Proc. Fifth Int. Conf. On Mars, Lunar and Planetary Institute contribution 972, 6093.

Muller, C., Moreau, D. Fonteyn, D., Bertaux,J.L. and. Korablev,O., 2001, SPICAM-light on Mars-Express as a monitor of surface UV radiation and atmospheric oxidants, Planetary and Space Science ,49, 165-171.