DEGRADATION OF β-CAROTENE UNDER UV-RICH IRRADIATION CONDITIONS: IMPLICATIONS FOR MARTIAN ENVIRONMENT. P. Vítek[1], J. Jehlička[1], J. Bezděk[2], E. Franců[2]. [1]Institute of Geochemistry, Mineralogy and Mineral Resources, Charles University in Prague, Albertov 6, 128 43 Prague 2, Czech Republic, vitek2@natur.cuni.cz, [2]Czech Geological Survey, Laboratory of Organic Geochemistry, Leitnerova 22, 658 69 Brno, Czech Republic

Introduction: If life ever evolved on Mars, it could leave molecular remnants – biomarkers which can be preserved within the Martian geological environment. It has been demonstrated that the survival of extremophiles in stressed terrestrial environments fundamentally depends upon their synthesis of a specialized suite of protective biochemicals in response to desiccation, low-wavelength high-energy radiation insolation, extremes of pH, temperature and pressure and high concentration of toxic heavy metal ions [1-3]. Such molecules could serve as potential biomarkers. One group of these protective biochemicals is carotenoids that serve both as light-harvesting pigment and also as cellular DNA damage-repair agents [4]. Thus, β-carotene, widely found in variety of halophilic species on Earth, could be a significant biomarker. It is known, that the molecule of β-carotene is sensitive to solar radiation, heating, as well as to reactive oxygen species (for example [5]). Thus the question arises – may it be preserved on Mars? In this study we have exposed pure β-carotene to the light obtained by metal halide lamp in order to simulate Mars irradiation mainly in the UV region. The protective role of the mineral matrix was also studied and is further discussed.

Method: A 150 W metal halide discharge lamp (Osram HTI) was used for irradiation. The output light flux was checked by the spectroradiometer USB2000 (Ocean Optics). Lamp was calibrated to give ~40 W m^{-2} in the range 250-400 nm, which roughly corresponds to the noontime equatorial insolation (UV) on Mars as predicted by Patel et al. [6] for low atmospheric dust conditions. The UV flux of the lamp is about 42 % of the intensity in the range 250-850 nm. The spectral profile of the discharge lamp is deficient in the longer wavelengths compared to the solar irradiation.

Samples of β-carotene (0,5 mg) precipitated from n-hexane on the aluminium dishes were exposed to irradiation mentioned above for various time periods (15, 30, 60, 180 and 360 min). Samples were cooled to ~278 K during exposure. These results were compared to the samples which were exposed simply on air in the dark under room temperature for the same periods of time. Protective role of the Martian regolith was tested by shielding the samples by 0,1 g of the Martian regolith simulant (JSC Mars-1A), forming thin layer, but still partly allowing the light to approach the sample during 60 min exposure. β-Carotene was redissolved in n-hexane after exposure. Concentration of total β-carotene in the processed samples was checked by the HPLC technique.

Results and Discussion: As shown on the figure 1, systematic decrease of β-carotene concentration was observed with the prolonging exposure to UV-rich irradiation. The decrease is significantly higher compared to the non-irradiated samples. Only 31 % of β-carotene was recovered after 360 minutes of irradiation.

As suggested from the results of the Viking mission and further predicted by many authors − it seems to be important to search for organics in the Martian subsurface. This preliminary study confirms this suggestion. Since evaporitic rocks are suggested as potential habitats for extinct/extant biota on Mars [7,8], the incorporation of molecular remnants within these rocks may be important as well as shielding by the mineral layer containing opaque minerals.

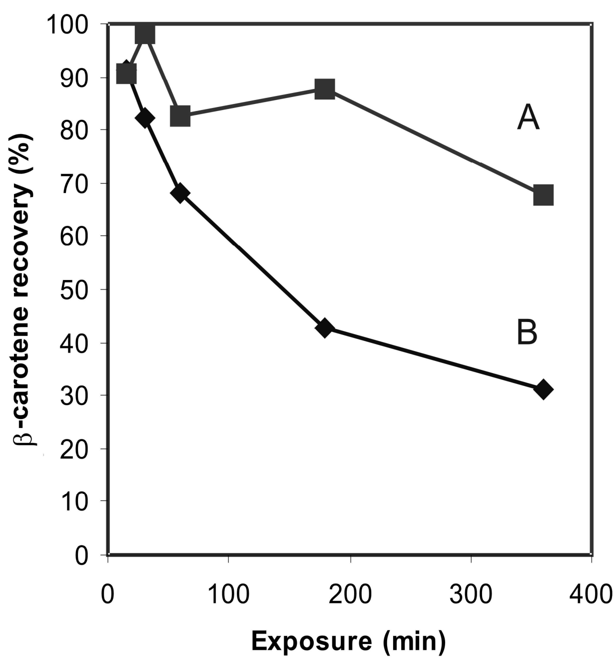

Figure 1: Exposure of β-carotene on air at the room temperature (A) compared to the effect of UV-rich irradiation of samples (B) for the same time periods.

This suggestion was confirmed by our results shown in the figure 2, where the positive effect of shielding the sample by the Martian regolith simulant is evident. The β-carotene recovery from the shielded sample was 85,3 % after 60 minutes of exposure, whereas irradiated sample without shielding resulted in the recovery of 71,5 % of initial β-carotene content. 94,1 % of β-carotene was recovered from the samples exposed only on air at the room temperature.

It can be concluded that thin layer of opaque minerals can protect the carotenoid degradation caused directly by irradiation. But more "tight" incorporation in the mineral matrix can be expected to be crucial for long-term preservation and protection against reactive oxygen species.

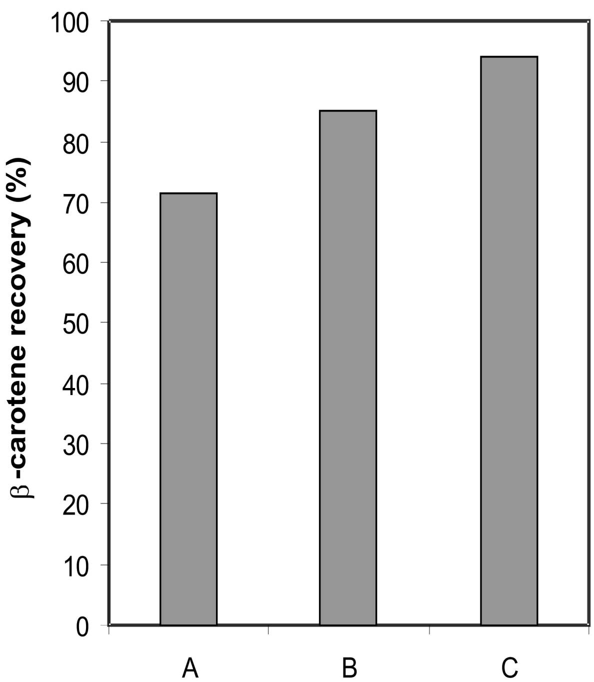

Figure 2: (A) β-carotene recovery after irradiation for 60 minutes, (B) β-carotene recovery from the samples screened by the Martian regolith simulant after irradiation for 60 minutes. (C) β-carotene recovery after exposure on air at the room temperature for 60 min without any irradiation. Presented results are medians from at least four samples.

Conclusions: The systematic β-carotene degradation with the prolonging exposure of UV-rich irradiadion was registered. According to general suggestions, the subsurface conditions seems to be crucial for preservation carotenoid-like molecules in terms of UV shielding and isolation from reactive oxygen species as well.

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