

PRESERVATION OF ORGANIC MOLECULES UNDER COSMIC RAYS IN MARTIAN SURFACE ROCKS. A. A. Pavlov¹, D. Glavin¹, H. McLain¹, J. Dworkin¹, J. Elsila-Cook¹ and J. Eigenbrode¹ ¹NASA Goddard Space Flight Center, Greenbelt MD 20771 (alexander.pavlov@nasa.gov).

Introduction: Organic molecules in the top meter of Martian rocks are poorly protected from Cosmic Rays radiation. Yet, the entire strategy of the Mars Exploration Program's search for the extinct life on Mars is based on the assumption that some original complex organic molecules would be able to survive for hundreds of millions - billions of years in the ancient Martian outcrops. Therefore, it is critical to understand the preservation of organic molecules under various dosages of ionizing radiation.

Recent modeling studies [e.g. 1] suggested that amino acids with masses >100 amu would be effectively destroyed in less than 1 billion years in the top 5 cm of the Martian rocks. However, Pavlov et al (2012) calculated the fraction of the survived organic molecules using conservative radiolysis constants derived from the gamma irradiation experiments on pure dry amino acid mixtures [2]. Cosmic rays can produce oxidative radicals in the immediate vicinity of the organic molecules within the rocks and increase the rate of organic degradation.

Methods: To evaluate the rate of amino acids degradation by cosmic rays in Martian rocks we exposed amino acids (AAs) mixed with SiO₂, hydrated SiO₂ and SiO₂/perchlorate powders to gamma ray ionizing radiation (an analogue of CRs) at room and -50 C temperatures. For the analysis of AAs abundance and distribution in SiO₂ powder we used the extraction procedure and liquid chromatography time of flight mass spectrometry techniques from [3]. The effects of accumulated dosage of up to 2 MGy were investigated by comparing the amount of AAs compounds in control (nonirradiated) samples relative to irradiated materials.

New radiolysis constants for aminoacids were derived. Radiation accumulation rates in the Martian rocks were derived with the state-of-the-art GEANT4 code. Newly derived radiolysis constants were then combined with the radiation accumulation rates to determine the rate of organic destruction and alteration by Galactic Cosmic Rays (GCRs) and Solar Cosmic Rays (SCRs) on Mars.

Results: 1) The destruction rate of amino acids in silicate powder mixtures is dramatically higher than in pure dry amino acid mixtures. Therefore, all amino acid molecules, which were either produced (by biosphere or deposited (by meteorites) on Mars earlier than 50-100 million years ago would have very little chance of survival without alteration in the surface Martian rocks.

2) The destruction rate of all amino acids increases dramatically even further if several percents of H₂O are added to the SiO₂. Therefore, hydrated minerals are the worst place to look for the intact ancient organic molecules on Mars.

3) Cold temperatures (-50 C) slow down the rate of amino acid degradation slightly. However, even under cold temperatures amino acids would be mostly destroyed in just 50-100 million years of cosmic ray exposure in the top meter of Martian rocks.

4) Effect of perchlorates will be reported at the meeting.

References: [1] Pavlov A. A. et al. (2012) GRL doi:10.1029/2012GL052166. [2] Kminek, G., and J. Bada (2006), Earth Planet. Sci. Lett. 245, 1-5. [3] Glavin D & Dworkin J (2009) P Natl Acad Sci USA 106(14):5487-5492.