SURVIVABILITY OF BIOMOLECULES ON MARTIAN SURFACE AGAINST SHOCK EFFECTS, AND RADIATION. Gözen Ertem[1], George Cooper[2] and Chris McKay[3]. [1]University of Maryland, Department of Atmospheric and Oceanic Science, College Park, MD 20742, [2,3]Space Science Division, NASA Ames Research Center, Moffett Field, CA, 94035

Introduction: Survivability of organic compounds delivered to Mars via meteorites and interplanetary dust particles must be considerably different than those on Earth as a result of thin Martian atmosphere [1]. Our research designed to investigate the effects of UV radiation on the survivability of biomolecules mixed with Martian analogue minerals demonstrated only 1-2% organic lost. Irradiation was carried out in a Martian Simulation Chamber. Samples were exposed to UV radiation to correspond to 0.028 $W. m^{-2}. nm^{-1}$. In the absence of minerals, the same organic compounds were completely converted into products without any chromophore group [2].

We are going to present our findings obtained by gamma irradiation of bio-molecule-Martian analogue mixtures under CO_2 atmosphere and in dry- and wet states and in the presence and absence of Martian analogue minerals. While UV radiation has an energy range between 3.1 eV – 124 eV (5×10^{-19} to 2×10^{-17} Joule), energy of gamma radiation is much higher than 1 MeV ($> 2 \times 10^{-14}$ Joule). As biomolecules, we have used purine, pyrimidine and uracil: Since RNA and DNA can be considered as derivatives of purine, pyrimidine, and uracil, these bases are crucial biomolecules in scenarios of prebiotic molecular organization, in the events leading to the origin of life, as well as in extant living systems. As minerals, in addition to calcite, gypsum, kaolinite and hematite, we have used two types of montmorillonites: One with high charge deficiency known as Otay and one with low charge deficiency known as Swy-2. Montmorillonite is a member of phyllosilicate group minerals. Extent of catalytic activity of montmorillonites to form short RNA chains vastly varies with their charge deficiency [3]. Results obtained in this work will provide useful information whether the extent of their protective role for biomolecules against gamma radiation also depends on their charge deficiency [3].

Irradiation of Martian analogue rocks and minerals with high doses of gamma radiation, 3×10^7 rads, neither cause any radioactivity in the samples nor any measureable changes in their isotopic and chemical compositions [4].

We have also shown that biomolecules undergo rapid oxidation upon mixing with hematite, Fe_2O_3, which decomposes these compounds in ambient light upon mixing, before UV irradiation. In fact, rapid photo-oxidation has been observed for other transition metal oxides, for example in the rapid decomposition of the pentose sugars arabinose, lyxose, ribose, and xylose in the presence of rutile (TiO_2) under ambient light conditions, but not in darkness [5].

We shall also present our results obtained from the analysis of biomolecules extracted from mineral-organic mixtures containing increasing ratios of hematite, Fe_2O_3. As the second mineral to be mixed with hematite, we have chosen corundum, Al_2O_3, which has a similar specific gravitiy to hematite: 5.0-5.3 for hematite and 3.95-4.10 for corundum.

Lastly, we shall present the results obtained from the analysis of organics extracted from Martian analogue mineral-biomolecule mixtures that have been subjected to shock pressures ranging from 10 to 40 Giga Pascal. Analysis of organics extracted from impacted mixtures was performed by using HPLC for 5'-AMP and 5'-CMP with a reverse phase column. D,L-alanine was analysed by GC-MS after converting it to its volatile forms. Organics in mixtures subjected to 40 GPa shock pressures were completely destroyed. However, we know that a multitude of meteoritic compounds survive impacts. Hence, we have repeated the experiments at lower shock impacts, where samples have experienced impact pressures of 10 GPa and 25 GPa.

Information obtained from these laboratory studies may be used to develop strategic exploration methodologies aimed toward the rapid identification of sample targets for in-situ astrobiological investigations.

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