Nucleic Acid Components adsorbed on mineral surfaces: A test bed for searching signs of life on Mars

Teresa Fornaro[1,2,3], John Brucato[1], Malgorzata Biczysko[4,5] and Vincenzo Barone[2]

[1]INAF – Astrophysical Observatory of Arcetri, Firenze, Italy; [2]Scuola Normale Superiore, Pisa, Italy; [3]Carnegie Institution for Science, Washington DC, USA; [4]CNR - Institute of Chemistry of Organometallic Compounds - UOS Pisa, Pisa, Italy; [5]Physics Department, and International Centre for Quantum and Molecular Structures, Shanghai University, Shanghai, China

Spectroscopic studies of UV radiation on biomolecules such as nucleic acid components found in heterogeneous environments are particularly relevant in prebiotic chemistry to unravel the role of minerals in the transformation/preservation of biomolecules in abiotic environments. Minerals may have a pivotal role in the prebiotic evolution of complex chemical systems, mediating the effects of electromagnetic radiation, influencing the photostability of biomolecules, catalysing important chemical reactions and/or protecting molecules against degradation. Studies on the photodegradation of biomolecules adsorbed on minerals have applications also in the life detection context to identify potential biomarkers for future space mission and hence to develop suitable sample-extraction protocols for bioanalytical instruments [1]. Moreover, the characterization of the spectroscopic features of biomolecules-mineral complexes provides a support in remote sensing spectroscopy for detecting organic compounds on planetary surfaces or cometary grains and asteroid surfaces.

In particular, nucleobases are prebiotically relevant molecules to investigate, being coding components of nucleic acids, and are of interest also from the standpoint of the preservation of biological systems in space conditions. It is believed that nucleobases might have played a critical role at the dawn of life due to their photoprotective properties. Indeed, several studies on the photodynamics of nucleobases suggest that their structure could have been naturally selected for the ability to dissipate electronic energy through ultrafast photophysical decay [2]. In this context we will present laboratory results on UV photostability of nucleobases adsorbed on Martian soil analogues, such as magnesium oxide and forsterite minerals, and analysed with infrared spectroscopy [3,4]. The interpretation of such results required a strong synergy between experimental and computational studies since spectroscopic data may be rather intricate when dealing with such complex systems, which are characterized by various types of intermolecular interactions influencing vibrational frequencies. For this reason we will show a general, reliable and effective computational protocol for analysing infrared spectra of nucleic acid bases - solid-support complexes [5-8].

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