STUDY OF THE EVOLUTION OF NUCLEOBASES UNDER MARS-LIKE CONDITIONS: IMPACT OF UV-IRRADIATION AND PERCHLORATES ON URACIL AND CYTOSINE.

Naïla Chaouche*[1], Fabien Stalport†[2], Herve Cottin‡[1], Thomas Audoux§ , Laura Rouquette¶ , Cyril Szopa‖[4,3], Patrice Coll**[5], and Jerôme Lasne

[1]Laboratoire inter-universitaire des systèmes atmosphèriques – Centre National de la Recherche Scientifique : UMR7583, Université Paris-Est Créteil Val-de-Marne - Paris 12, Université Paris Diderot - Paris 7, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers – 61 Av du général de Gaulle 94010 CRETEIL CEDEX, France

[2]Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA) – Université Paris Est (UPE) – France

[4]Laboratoire Atmosphères, Milieux, Observations Spatiales – Université de Versailles Saint-Quentin-en-Yvelines : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Sorbonne Universite : UMR8190, Centre National de la Recherche Scientifique : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190, Institut national des sciences de lÚnivers : UMR8190 – 11 boulevard dÁlembertQuartier des Garennes 78280 - Guyancourt, France

[3]Institut Universitaire de France (IUF) – Institut universitaire de France, Institut universitaire de France – France

[5]Laboratoire inter-universitaire des systèmes atmosphèriques (LISA) – Université Paris Diderot - Paris 7, Centre National de la Recherche Scientifique : UMR7583, Université Paris-Est Créteil Val-de-Marne (UPEC), Paris – 61 Av du général de Gaulle 94010 CRETEIL CEDEX, France

*Speaker
†Corresponding author: fabien.stalport@lisa.u-pec.fr
‡Corresponding author: herve.cottin@lisa.u-pec.fr
§Corresponding author: thomas.audoux@lisa.u-pec.fr
¶Corresponding author: laurarouquette@hotmail.fr
‖Corresponding author: cyril.szopa@latmos.ipsl.fr
**Corresponding author: pcoll@lisa.u-pec.fr

Abstract

The search for organic molecules is one of the main goals of current and future Martian space missions. Many sources of organic molecules may exist at the surface of this planet: exogenous sources, such as the interplanetary medium, and/or endogenous sources, like hydrothermalism or a potential biological activity. However, only a few organics have been detected so far and their relation to any endogenous sources or to the compounds that are brought to the surface by interplanetary bodies is not straightforward.
An explanation is that organic molecules are not well preserved in the Mars surface environment. This environment is characterized by different parameters *i.e* strong oxidants (perchlorates, iron oxides...), energetic radiation (UV, X-rays...) that could degrade or alter the organic matter. Therefore, the study of the possible actions of these harsh conditions on organic molecules is of high interest for the quest of organics on Mars, and this is the objective of the present work.

Perchlorates have been detected in the Martian regolith, (0.4-0.6% by weight). They are strong oxidants (containing ClO4- ions) and could react with organics especially when they are activated by energetic sources, such as X-rays and UV light. This could explain why it is so hard to detect organics on the surface and near-surface of Mars. It could also possibly be a source of the chlorohydrocarbons detected with the SAM experiment in gale crater. This is the reason why we started studying the possible interaction between UV radiation reaching the surface of Mars with organic molecules of high interest for astrobiology.

The MOMIE (Mars Organic Matter Irradiation and Evolution) experiment is designed to study the evolution of organic molecules in a simulated Martian environment with respect to temperature, pressure and UV radiation. In the context of prebiotic chemistry, nucleobases are organic molecules of interest. Furthermore, some nucleobases were detected in meteorites and were therefore brought to the surface of Mars at some point. Finally some of them are UV resistant or produce UV resistant photoproducts under Mars-like conditions. To investigate the effect of perchlorates on nuclaobases and their UV photoproducts on Mars, we studied nucleobases with the MOMIE experimental setup.

This study is focused on the evolution of nucleobases (uracil, cytosine...) in the presence of a calcium perchlorate in the solid phase.
Our results show that perchlorates accelerate the degradation of uracil under UV-irradiation compared to the evolution of uracil alone under the same UV flux. Concerning Cytosine, a new compound is formed when this molecule is in contact with perchlorates even if the sample is not exposed to any UV radiation. The presence of UV radiation increases the photodegradation rate of this new compounds. From these results, it can be concluded that the presence of nucleobases and their photoproducts in the first centimeter depth of the martian regolith is highly uncertain.