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Laboratory simulations of Martian conditions: hints for detection of molecular biomarkers on Mars

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Laboratory simulations of Martian conditions provide an essential support to current and future exploration missions devoted to detection of molecular biomarkers on Mars. Some organic compounds recently detected in the harsh conditions at the surface of Mars are the products of transformation of organic precursors whose nature is still under discussion. The inspection of the transformation processes of potential biomarkers under Martian-like conditions may be crucial to investigate the possible biogenicity of the precursors and identify the most suitable conditions for their preservation, developing models for their degradation at geological timescales.
Accordingly, we present laboratory activities of preparation, characterization and ultraviolet (UV) irradiation processing of Mars soil analogues. We have prepared Mars soil analogues by doping natural and synthetic minerals with organic compounds considered as biomarkers under controlled coverage conditions using an equilibrium adsorption method. Subsequently, we have employed Fourier Transform Infrared (FTIR) and Raman spectroscopy to gain insight into specific molecule-mineral interactions. Furthermore, we have investigated the effects of UV radiation on molecule-mineral complexes under simulated Martian conditions through UV irradiation processing, by focussing UV light on samples placed within a reaction chamber under controlled pressures and temperatures in simulated Martian atmosphere and monitoring the photochemistry through infrared spectroscopic analysis.
These studies are not only key for identification of potential molecular biomarkers, but also for selection of sampling sites on Mars for future exploration missions, correct interpretation of data collected on the ground, and development of suitable life detection methods and technologies for in situ analysis.
Furthermore, these investigations may provide a crucial contribution to address questions about the origin of life. Indeed, studies about the molecule-mineral interactions and the effects of UV radiation on organics in heterogeneous environments are particularly relevant in prebiotic chemistry, to figure out the role of minerals in the transformation/preservation of organic matter and investigate the physico-chemical mechanisms leading to the synthesis of more complex chemical compounds in extraterrestrial environments.