Mineral-mediated evolution of polycyclic aromatic hydrocarbons

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Abstract

Polycyclic Aromatic Hydrocarbons (PAHs) make up 75% of the organic content of meteorites (Sephton, 2014), and have been found on asteroids, comets and planetary surfaces like those of Earth and Mars. PAHs and PAH clusters are responsible for the 3-15 μm infrared emission bands which have been observed in remarkably similar quantities across the observable universe (Pendleton & Allamandola, 2002). However, when adsorbed to the rocky bodies of our solar system, PAHs undergo a different chemical evolution than they would in gas phase. How this macromolecular carbon evolves once it is deposited on planetary surfaces is a subject of interest when establishing the organic carbon inventories available for ensuing chemical complexification.
Here we test the hypothesis of whether these macromolecular compounds, and especially PAHs, could serve as a carbon source for the synthesis of some of the building blocks of life. We propose that the presence of mineral catalysts in the substrates of small bodies and planetary surfaces facilitates the breakdown of PAHs, freeing up the carbon and making it available to generate precursor prebiotic compounds.

This work focuses on laboratory studies using simulation chambers designed to mimic various bodies in our solar system. Experiments were performed at the INAF Observatory of Arcetri and in the PALLAS chamber at Utrecht University. Mineral samples were spiked with PAHs and subjected to solar-type UV radiation. A combination of infrared spectroscopy and mass spectrometry was used to monitor the change in the nature of the bonds and to characterize any reaction products.

Sephton, M. A. (2014). Organic geochemistry of meteorites. Elsevier Ltd.
Pendleton, Y. J., & Allamandola, L. J. (2002). The organic refractory material in the diffuse interstellar medium: mid-infrared spectroscopic constraints. The Astrophysical Journal Supplement Series, 138(1), 75.

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