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Surface Hydrothermal Vents as Sources of Prebiotic Nitriles and Isonitriles

PAUL RIMMER, SAI SHRUTHI MURALI AND OLIVER SHORTTLE

University of Cambridge

Presenting Author: pbr27@cam.ac.uk

Nitriles such as hydrogen cyanide and cyanoacetylene are useful molecules for making life's building blocks: nucleotides, amino acids and phospholipids [1]. Hydrogen cyanide can arise in several diverse geochemical settings [2,3], but it is unclear under what geochemical conditions cyanoacetylene can be produced [4,3]. Additionally, methyl isocyanide has been shown to be a critical molecule for linking together nucleotides, amino acids and phospholipids the same way enzymes link them together [5,6], but there is only one proposed geochemical source of methyl isocyanide [5]. Finally, many of the proposed scenarios for making nitriles involve reducing conditions, and these conditions can result in a mess of thousands or even millions of other molecules.

In this talk, I will present a scenario that produces a clean chemical mixture rich in nitriles and isonitriles. The scenario involves >1600 deg C highly-reduced nitrogen-rich volcanic gas [7,8]. When equilibration with graphite is considered, both kinetics and equilibrium models predict that the chemistry cleans up, leaving behind mostly H2, N2, CO, CO2, CH4 and H2O with predicted concentrations of hydrogen cyanide at 1%, methyl isocyanide at 10 ppm and cyanoacetylene at 1 ppm [8]. If cyanoacetylene is produced, it is an open question whether it will partition into water and how long it will survive. I will present new experimental work to measure the partition coefficient and lifetime of cyanoacetylene. I will conclude by talking about future work in theory, experiment and observation to find out whether this scenario will result in the predicted chemistry, what other chemical conditions will likely be present in this scenario, and whether other scenarios could host similar chemical conditions.

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