Investigating the Stability of Prebiotic Uracil Under the Conditions of Impact-Generated Terrestrial Hydrothermal Systems

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It's been hypothesized that carbonaceous chondrite meteorites can transport compounds crucial to planetary habitability. Meteorites generate hydrothermal systems through impact energy dissipation, however scientists hadn't assessed whether these molecules could survive extreme changes in these environments. My research seeks to address this gap by assessing the change in concentration, specifically of uracil, in these conditions. I previously researched uracil's stability under high pressure and temperature, which yielded shocking results suggesting uracil is more stable under these conditions. This project expanded with varied temperatures, anaerobic environments, and olivine, an oceanic crust mineral associated with hydrothermal convection. I recreated hydrothermal conditions in a laboratory and used spectrophotometry to determine sample concentrations. Despite initial difficulty drawing temperature data due to fluctuations, the samples containing olivine consistently demonstrated a higher uracil concentration. I retested and found a corroboration of previous trends, but an interesting fluctuation between room and extreme temperatures. I also tested dunite and found it did not affect uracil's stability. My current hypothesis is that mineral olivine more immediately functions as a mineral substrate, whereas dunite is susceptible to alteration into serpentine minerals, insulating uracil over geological timescales. This suggests that uracil can be delivered by meteorite and thrive in hydrothermal environments. This research has implications in habitability, environmental studies, and aerospace. While the gap between nonliving matter and life remains, this research provides a blueprint to strategically aim aerospace missions, wasting less resources and limiting emissions.

Awards Won:

First Award of $6,000