The Stability of biological Nucleobases and Nucleosides in Hydrothermal Fluids

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Nucleobases are attached to the DNA backbone via the glycosidic linkage which undergoes spontaneous hydrolysis at 25°C.[1] Such hydrolysis reactions are anticipated to result in endogenous DNA damage (i.e. mutation) and are regarded as a thermodynamic obstacle to the aqueous condensation route in prebiotic synthesis. However, recent flow-through experiments on the stability of the glycosidic linkage in adenosine[2] point to a thermodynamic favour for nucleoside synthesis in hydrothermal environments. Prompted by these findings and recent reports on the kinetics of dinucleoside hydrolysis at elevated temperatures[3] we are currently undertaking a systematic study of selected nucleobases and nucleosides in hydrothermal media. Experiments were conducted in both Varian Cary 4E uv-vis spectrophotometers containing a high temperature high pressure Au-lined optical cell and large-volume Au-cells in conjunction with ion-chromatography. For every experimental run, nucleobase or nucleoside stock solutions (~10^{-5}m) were pumped into the preheated Au-cell and absorption spectra collected in batch-flow mode for time periods up to 6 hours. A preliminary analysis of adenine base and adenosine nucleoside absorption spectra at temperatures of 90°C, 140°C, 180°C and 220°C demonstrates (1) the establishment of a steady-state between the nucleoside and product nucleobase and ribose for each temperature and (2) a substantial lowering of the adenine decomposition rate in Au-cells compared to previous experiments in quartz.[4] The observation of a high temperature steady-state between nucleoside, nucleobase and ribose is of interest and will await further examination from both uv-vis spectroscopic and flexible Au-cell studies. Knowledge of nucleoside hydrolysis as well as nucleobase decomposition rates and selected equilibrium constants at elevated temperatures is important to our understanding of prebiotic synthesis in hydrothermal environments.

References

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