Supercritical fluids in the search for origins-of-life in Earth and beyond

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The origins of life is unresolved. The path leading to a self-sustainable complexed chemical system is yet unknown, and at the core of this system exists a two-biopolymer (nucleic acids and proteins) system conserved in all life forms on Earth. This system is supported by an aqueous condition maintained by water. In this context, water has been considered as a sign for habitable environment on Earth and beyond where life can emerge. However, the abiotic synthesis of biopolymers is thermodynamically unfavorable in water. The paradox behind the water prone biopolymer and the water as a biosolvent bring into question whether alternative solvents existed on early Earth to drive chemical reactions leading to more complexed molecules including biopolymers.

In this study, we aim to investigate the effect of supercritical carbon dioxide ($scCO_2$) upon chemical reactions that are difficult to occur in aqueous conditions. $scCO_2$ has been known for its use in the industry as a ‘green’ solvent, however it has also found in deep-sea environments in modern ocean and more likely to be present in Hadean Earth which could have served as the key matrix to promote other different chemistry from aqueous chemical reactions. We will focus on two fundamental steps towards the formation of biopolymers 1) Non-enzymatic synthesis of nucleotides (from nucleobase, sugar and phosphate), 2) Condensation of nucleotides and amino acids towards abiotic synthesis of the two-biopolymer architecture.

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