Hydrogels: Lets thicken the Prebiotic soup

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Introduction: The commonality between gels and cells provides compelling grounds for exploring the relevance of gels in the origin of life. Herein, we draw parallels between the behavior of cytoplasm in contemporary cells and hydrogels. There is need for the exploration of hydrogels in particular, keeping in mind the geological relevance of inorganic species to origins of life[1]. One of the fundamental problems in prebiotic chemistry is the control of water activity in aqueous media (in peptide bond formation, phosphorylation, nucleotide polymerization), which is, thermodynamically, an uphill task.

Our investigation into the importance of inorganic hydrogels began with study of D-ribose. D-ribose ($C_5H_{10}O_5$) is highly important because it is an integral part of DNA and RNA. The half-life of this molecule presents a considerable challenge in studying its role in origins of life. At pH 9 and 60°C, its half-life is about 50 h; in physiological conditions, at pH 7 and 37°C, it would be around 500 h if one extrapolates from the data of [2]. In solution, the D-ribose is in equilibrium with four isomers : α- and β-pyranose (β is the dominant isomer, 83%), and α- and β-furanose.

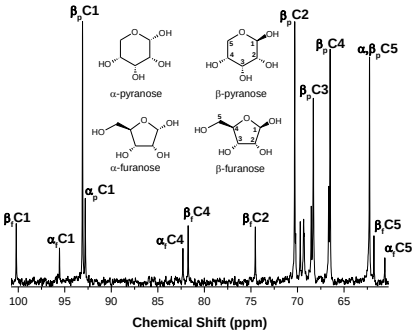

Figure 1 – 13C NMR showing the isomeric forms of ribose in solution.

Here, we present the homogenisation of ribose into hydrogel and the analysis of its diffusion properties in addition to its chemical and thermal stability. About 90% of the mobility of ribose is conserved in the hydrogel environment, which is similar to water, thus analogous to a cell environment. 1H NMR (DOSY sequence) was used for characterising the mobility of ribose in the gel. This environment also has effects on isomerization of D-ribose. We have not observed an evolution in the pyronose/furanose ratio, but have observed a progression of β-forms and a decrease of α-forms. *In situ* NMR and Raman spectroscopy have been used in order to evaluate the thermal behavior of ribose in the gel and in hydrothermal conditions on gels. Preliminary studies show a better thermal stability of the D-sugar in the gel. Hydrogels provide an environment and dynamics that are distinct from those in solution but nevertheless retain fluidity at a slower pace within a confined spatial arrangement. Such hydrogel matrices could also facilitate specific chemical interactions that appear to be necessary for prebiotic chemistry. Investigations on such properties are in progress [3].

References: [1] Akouche et al. (2016) *Chemistry- A European Journal* 22, 44, 15834–46. [2] Larralde et al. (1992), *PNAS* 92(18), 8158-60. [3] Dass et al. (2016) *Chemistry Select* 1,15, 4906–26.