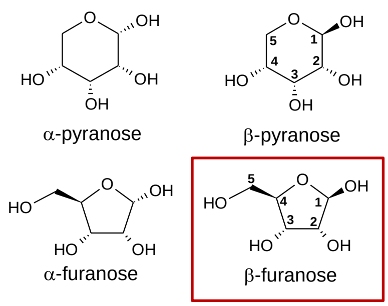
RIBOSE BEHAVIOR IN SILICA HYDROGEL. Avinash Dass[1], Thomas Georgelin[1,2], Frederic Foucher[1] Terence Kee[3], Frances Westall[1]. [1]CNRS-CBM- Orléans, France, [2]Sorbonne Universités, UPMC Paris 06, CNRS UMR 7197, Laboratoire de Réactivité de Surface, 4 place Jussieu, F-75005 Paris-France, [3]School of Chemistry, University of Leeds, Leeds, West Yorkshire, UK

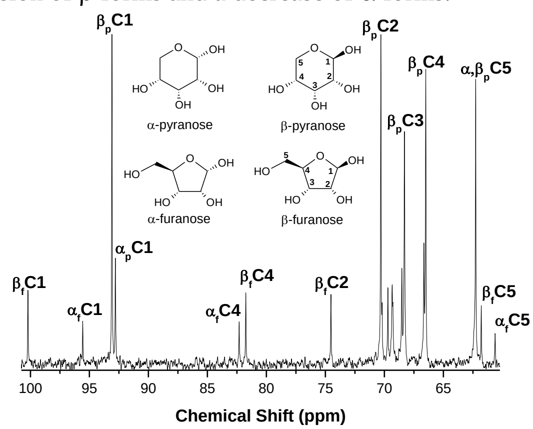
Introduction: Sugars are one of the most important classes of molecules, essential for all life species and extremely recoverable for biocatalysis of biomass. However, some of sugars are unstable in solution, such as D-ribose ($C_5H_{10}O_5$)[1]. This sugar is highly important for life because it constitutes the carbohydrate part of DNA and RNA. For example, at pH 9 and 60°C, its half life is about 50 h; in more physiological conditions, at pH 7 and 37°C, it should be around 500 h extrapolating from the data of Miller and coworkers[2]. In solution, D-ribose is in equilibrium with four isomers : α-pyranose, β-pyranose, α-furanose, β-furanose.



The main forms in liquid water are pyranose species (83 %). In order to understand the presence of D-ribose in these biopolymers, it is essential first to stabilize the molecule and secondly to explain the selectivity for β-furanose. Association of the sugar with minerals could help prevent degradation and chemically stabilize the sugar [3], especially porous materials, such as clays. Minerals present a second advantage because some surfaces are able to promote chemical condensation reactions[4, 5].

A new class of materials is relevant for prebiotic chemistry: silica hydrogels. Such gels would have been common on the primitive Earth due to rock dissolution in acidic seawater and by hydrothermal fluids. Silica gel acts as inorganic vesicles and could be considered as a primitive inorganic cells. In addition to stabilization, a molecular species must be mobile in the gel in order to preserve their ability to participate in prebiotic reactions.

Here, we describe the incorporation of ribose in gel, analyzing the diffusion properties and the chemical or thermal stability. ^{13}C NMR (DOSY sequence) was used to characterize the mobility of ribose in the gel and its isomerization. Our results show that ribose preserves 90% of its mobility in the gel compared in water. Moreover, in the gel, the isomerization of ribose changes. Although we have not noted an evolution in the ratio pyronose/furanose, we have observed a progression of β forms and a decrease of α forms.



In situ NMR and Raman spectroscopy have been applied to evaluate the thermal behavior of ribose in the gel in hydrothermal conditions. Preliminary results seem to indicate better thermal stability of sugar in the gel. All these results open the door for future prebiotic reactions in silica hydrogel.

References:

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