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Increasing the Relative Production of Ribose Under Mild Prebiotic Conditions

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During the abiotic stage of the early earth, meteorites were delivering abundant and diverse organic compounds to our planet and there was also (likely) indigenous production. Among these compounds were sugars. Since discovering the importance of ribose in biology scientists have wondered how this apparently labile compound came to biological prominence: was ribose synthesized in sufficient relative quantities (compared to other sugars) to form a polymer such as RNA? For example in the classical formose reaction, the most cited prebiotic reaction for producing sugars, ribose is usually a minor component [1]. Prebiotic chemists have strived to answer this question by various experimental methods. For example, the Benner group has shown a preferential synthesis of ribose in the presence of borate minerals [2]. Also, Geoffrey Zubay, using lead as a catalyst in the production of sugars, suspected that ribose was a primary product among resulting aldopentoses [3]. We addressed the question of prebiotic ribose abundance by manipulating various parameters in formose-type reactions. We used known meteoritic (i.e., prebiotic) minerals such as Na^{+}, Ca^{2+}, and Mg^{2+}, anions, and photolysis at multiple wavelengths. The resulting compounds were analyzed as their (+)butyl/trifluoroacetyl derivatives by gas chromatography–mass spectrometry. In preliminary experiments we find the abundance of ribose can be significantly increased relative to other sugars (Fig. 1). We can vary this relative abundance depending on reaction parameters. Details of these methods and further results will be presented.

References: [1] Schwartz, A. W. and de Graaf, P. M. (1993) *Journal of Molecular Evolution* 36, 101-106. [2] Ricardo, A., Carrigan, M. A., Olcott, A. N., & Benner, S. A. (2004) *Science*, 303(5655), 196-196. [3] Zubay, G. (1998) *Origins of Life and Evolution of the Biosphere* 28(1), 13-26.

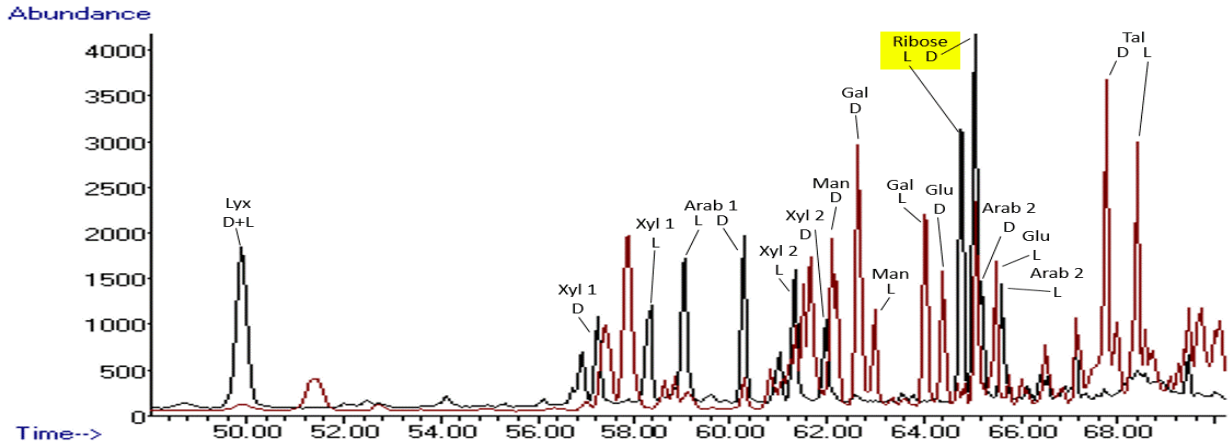

Figure 1 – Isotope (^{13}C) labeled 5C and 6C sugars from a formose-type reaction. The abundance of ribose is significantly increased compared to that in classic formose reactions, as well as other reactions we have performed (not shown) with different initial reaction parameters. (Ribose is racemic as shown by area integration).

Lyx=Lyxose, Xyl=Xylose, Arab=Arabinose, Man=Mannose, Gal=Galactose, Glu=Glucose, Tal=Talose; Numbers refer to different diasteriomers of a given compound.