

# The Prebiotic Chemistry of Sugars

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While many compounds found in modern terran life can be made by non biological processes, sugars have proven to be especially problematic. Over a century ago, Butlerov noted that by treating formaldehyde with calcium hydroxide, a sweet, complex mixture of compounds that contained sugars, including small amounts of ribose, could be produced. In 1959, Breslow provided a mechanism for how this "formose reaction" could do so catalytically, and we recently showed how borate minerals might stabilize the ribose that is formed. Extremely puzzling, however, has been the first step of the formose reaction, how two 1-carbon units (formaldehyde) can join to form one 2-carbon unit (glycolaldehyde). Detailed studies of the kinetics of this reaction now show that the reactive species is not formaldehyde itself, but rather a short fragment of the oligomer known as paraformaldehyde. Further, we have determined and interpreted the concentration dependence of this process, and that strontium, which is available in a variety of minerals, is a more effective cation than calcium. Implications of these observations on the prebiotic synthesis of ribose is discussed, as is the role of desert environments in managing the water problem, which hinders the conversion of these building blocks into oligomeric RNA.