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PREBIOTIC CHEMISTRY

Atmospheric Production of Glycolaldehyde Under Hazy Prebiotic Conditions

Chester E. Harman · James F. Kasting · Eric T. Wolf

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Abstract The early Earth's atmosphere, with extremely low levels of molecular oxygen and an appreciable abiotic flux of methane, could have been a source of organic compounds necessary for prebiotic chemistry. Here, we investigate the formation of a key RNA precursor, glycolaldehyde (2-hydroxyacetaldehyde, or GA) using a 1-dimensional photochemical model. Maximum atmospheric production of GA occurs when the CH_4:CO_2 ratio is close to 0.02. The total atmospheric production rate of GA remains small, only 1×10^7 mol yr^{-1}. Somewhat greater amounts of GA production, up to 2×10^8 mol yr^{-1}, could have been provided by the formose reaction or by direct delivery from space. Even with these additional production mechanisms, open ocean GA concentrations would have remained at or below $\sim$1 μM, much smaller than the 1–2 M concentrations required for prebiotic synthesis routes like those proposed by Powner et al. (Nature 459:239–242, 2009). Additional production or concentration mechanisms for GA, or alternative formation mechanisms for RNA, are needed, if this was indeed how life originated on the early Earth.

Keywords Prebiotic · Atmosphere · Chemistry · Glycolaldehyde · Fractal haze

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C. E. Harman (✉) · J. F. Kasting
Department of Geosciences, Penn State University, University Park, PA 16802, USA
e-mail: ceharmanjr@psu.edu

E. T. Wolf
Laboratory for Atmospheric and Space Physics, Space Science Building (SPSC), University of Colorado, 3665 Discovery Drive, Boulder, CO 80303-7820, USA