Thermal stabilities of amino acids in siliceous ooze under alkaline hydrothermal conditions

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Hydrothermal systems have been theorized to be a favorable environment for the origin and evolution of life on primitive Earth. To assess this hypothesis, it is necessary to investigate the behavior of basic biomolecules such as amino acids (AAs), which are a major component of the Earth's organism, under hydrothermal conditions. In contrast to submarine hydrothermal systems, hot springs in the Rift Valley in eastern Africa on the thick continental crust often have a high pH (alkaline condition) due to enrichment by sodium carbonate and volatile gases. In this study, we reacted siliceous ooze with a mixture of NaCl and Na_2CO_3 aqueous solution at elevated temperature (100–300°C) to evaluate the thermal stabilities of the AAs under alkaline hydrothermal conditions. The AAs existing in the sediment in peptide form were eluted to the liquid phase and decomposed through hydrolysis of peptide bonds. Comparison of the results with those from similar experiments using the same sediment sample under neutral conditions revealed that the rates of decomposition of the AAs were significantly retarded under alkaline conditions. Moreover, AAs remained in both the solid and liquid phases even after heating at 300°C for 240 h. Our results indicate that AAs are more thermally stable in alkaline solution, which provides a more favorable condition for primitive life to evolve in hydrothermal systems on the thick continental crust. Our results also imply that alkaline hydrothermal systems on other planets are the most plausible places for extraterrestrial life.

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