

Stable Carbon Isotopic Signatures of Abiotic Organics from Hydrothermal Synthesis Experiments

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Stable carbon isotopes can be powerful biogeochemical markers in the study of life's origins. Biogenic carbon fixation produces organics that are depleted in ^{13}C by about -20 to -30%. Less attention has been paid to the isotopic signatures of abiotic processes. The possibility of abiotic processes producing organics with morphologies and isotopic signatures in the biogenic range has been at the center of recent debate over the Earth's earliest microfossils.

The abiotic synthesis of organic compounds in hydrothermal environments is one possible source of endogenous organic matter to the prebiotic earth. Simulated hydrothermal settings have been shown to synthesize, among other things, single chain amphiphiles and simple lipids from a mix of CO , CO_2 , and H_2 . A key characteristic of these amphiphilic molecules is the ability to self-assemble in aqueous phases into more organized structures called vesicles, which form a selectively permeable boundary and serve the function of containing and concentrating other organic molecules. The ability to form cell like structures also makes these compounds more likely to be mistaken for biogenic.

Hydrothermal simulation experiments were conducted from oxalic or formic acid in water at 175°C for 72 hr. The molecular and isotopic composition of the products of these reactions were determined and compared to biogenic fractionations. Preliminary results indicate isotopic fractionation during abiotic hydrocarbon synthesis in hydrothermal environments is on par with biological carbon fixation. This suggests