Abundance of ^{13}C-^{13}C bonding in biotic and abiotic ethane measured by a new C_2F_6 method

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Abstract

Doubly-substituted isotopologue could be a potential tracer for biogeochemical processes, though the study of ^{13}C-^{13}C isotopologue is limited [1]. Here, we propose a new fluorination method for measuring ^{13}C-^{13}C isotopologue of C_2 molecules using a conventional isotope ratio mass spactrometer. Because fluorine has only one stable isotope, ^{13}C-^{13}C isotope species in C_2 molecules were measured as C_2F_6 arising from the fluorination of C_2 molecules. The method is applicable to ethane from natural gas samples but also to ethanol. Reproducibility of the whole protocol, including chemical modification steps and the mass spectrometry of C_2F_6 is 0.14‰ for the $\Delta^{13}C^{13}C$ value. We applied this method to sevral C_2 molecules: ethane from natural gas (thermogenic and abiotic), biologically derived ethanol as well as abiotic ethane produced by UV irradiation, spark discharge, Fischer-Tropsch synthesis and Gamma ray irradiation [2].

Ethane from thermogenic natural gas samples and biologically derived ethanol show a narrow range of $\Delta^{13}C^{13}C$ values varying from +0.72‰ to +0.90‰ relative to our tank C_2F_6 gas. In contrast, putative abiotic ethane from Kidd Creek show significantly lower $\Delta^{13}C^{13}C$ value of 0.25‰. Also, the ethane synthesized by all the experiments show the low $\Delta^{13}C^{13}C$ values similar to the Kidd Creek ethane or even lower. Therefore, C-C clumping may be useful to distinguish biotic and abiotic origins of C2 molecules.

[1] Clog M *et al*. (2018) *Geochim Cosmochim Acta* 223,229-244. [2] Boreham C J et al. (2020) Radiatio Physics and Chemistry 168,