Intramolecular carbon isotope signature of thermogenic and abiotic hydrocarbons

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Distinguishing hydrocarbons produced through non-biological processes from those derived from biology has implications for understanding Earth biogeochemistry [1] and for tracing biogenic and non-biogenic organic matter for extraterrestrial exploration and early Earth geological record [2,3].

We recently implemented an apparatus dedicated to the measurement of position-specific isotope analysis (PSIA) of short-chain hydrocarbons. The site preference SP of propane – namely the relative concentration of terminal ^{13}C-isotopomer vs. central one – can be determined with a precision better than 1‰ and with a sample amount as low as 50 nmol [4].

We tested this device by analyzing field samples (including samples from the hydrothermal system Hakuba-Happo, Japan [5]), as well as samples synthesized in the lab simulating thermogenic and abiotic processes (thermal cracking of organic matter and CH_4 polymerization, repsectively). We show that there is a systematic difference of intramolecular isotope distribution between thermogenic and abiotic samples. While the former show ^{13}C-depletion on the terminal C-atom position – consistent with thermal cracking kinetic models [6] – abiotic samples show little or no preference for terminal or central ^{13}C-isotopomer. These results reinforce the potential of PSIA to trace organic molecules and interrogate their biogeochemical origin.

[1] Sephton & Hazen, **2013**, Rev. Mineral. Geochem. 75, 449; [2] McCollom *et al*., **2006**, EPSL, *243*, 74; [3] Telling *et al*., **2013**, Astrobiology, *13*, 483; [4] Gilbert et al., **2016** GCA *177*, 205; [5] Suda *et al*. **2014** EPSL *386*, 112 [6] Tang *et al*., **2000** GCA *64*, 2673