

Evolution of carbon fixation through time

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The carbon isotopic difference between carbonate rocks and organic carbon provides a comprehensive record of the mode and variety of microbial carbon fixation through the progressive oxygenation of Earth's surface environment. Extracting this anabolic signal from the geologic carbon isotope record requires accounting for different carbon fixation pathways, physiological responses to changing environments, and, especially fractionations that occur as the primary substrates of carbon fixation are preserved in ancient rocks [1]. Here we present a new evaluation of the primary carbon isotope fractionation associated with evolution of carbon fixation through time, and interpret this record with quantitative bio-isotopic models of potential modes of carbon fixation, past and present.

We use a bootstrap resampling scheme over non-transitional intervals in the carbon isotope record and account for the transformation of dissolved CO₂ and primary biomass into carbonate minerals and organic carbon, as well as post-depositional changes. We identify cyanobacteria as the dominant primary producers during the Middle Proterozoic [2], and explore whether proposed carbon fixation pathways for anaerobic metabolisms are consistent with the early Archean carbon isotope record. The primary value of this approach will be to test hypotheses for the importance of various carbon fixation pathways during different stages of Earth's oxygenation by showing which may be plausible and, more importantly, which may not.

[1] Hayes JM, et al. (1999) *Chemical Geology* **161**, 103–125. [2] Hurley SJ, et al. (*submitted*)