The stable carbon isotopic composition of marine phytoplankton throughout the Phanerozoic

CAITLYN R. WITKOWSKI[1*], STEFAN SCHOUTEN[1,2], JAAP S. SINNINGHE DAMSTE[1,2]

[1] NIOZ Royal Netherlands Institute for Sea Research, Department of Marine Microbiology and Biogeochemistry, and Utrecht University, PO Box 59, 1790AB Den Burg (Texel), The Netherlands (*correspondence: caitlyn.witkowski@nioz.nl)

[2] Utrecht University, Department of Geosciences, PO Box 80.021, Utrecht, The Netherlands (stefan.schouten@nioz.nl, jaap.damste@nioz.nl)

^{12}C is preferentially discriminated over ^{13}C during the incorporation of external environmental inorganic carbon into the internal structures and through the synthesis of carbon into metabolic pathways in primary producers. To better understand the enviromental factors influencing this discrimination, the stable carbon isotopic fractionation associated with autotrophic inorganic carbon fixation (ε_p) was calculated from the stable carbon isotopic composition ($\delta^{13}C$) of the general phytoplanktonic biomarker phytane, a diagenetic product from chlorophyll-a. The compilation (data from the literature with complementary laboratory work) comprises of approximately 400 sediment and oil samples from open marine environments, and considers both free and sulfur-bound phytane. The resulting ε_p ranges from 12–24‰, agreeing the literature's postulated maximum Rubisco fractionation of 25‰. The trend in ε_p mirrors the compiled pCO_2 record from ~125 Ma to modern day, though ε_p has a negative offset from the pCO_2 record prior to 125 Ma and a larger offset prior to 350 Ma. The timing of these offsets coincide with the emergence of diatoms (radial centric at 142-97 Ma) and haptophytes (375-285 Ma), both of which have higher maximum fractionation than other phytoplankton due to their carbon fixing enzyme Rubisco, which has evolved in response to decreasing pCO_2. This factor should be considered when applying the $\delta^{13}C$ of phytane as a quantitative pCO_2 proxy in the Phanerozoic.