

CARBON ISOTOPIC FRACTIONATION OF NATURALLY OCCURRING
ALKENONE-PRODUCING ALGAE AS A FUNCTION OF SPECIFIC GROWTH
RATE

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CHAPTER 4 CONCLUSIONS

The ^{13}C labeling technique developed by Popp et al. (2006b) to measure the growth rate of alkenone producing haptophytes appears to work well in the field, subject to the pitfalls identified in this study. Namely, these are: (1) the challenge of carefully collecting and incubating water at the same depth to minimize the effect of increased light stimulation; and (2) the difficulty of collecting alkenones in quantities sufficient for replicate carbon isotopic analysis, given the relatively low alkenone concentrations observed in some regions. These issues have been addressed to some degree in subsequent incubation experiments conducted in the Guaymas Basin and eastern north Pacific (manuscript in preparation). Despite these challenges, the number of samples collected in this study allowed the data to be pared to include only those not hindered by these limitations. This growth rate, in turn, allowed the relationship between ϵ_p , μ , and C_c to be probed in four distinct oceanic regions.

Thus far, quantitative paleo- pCO_2 reconstructions based on sedimentary alkenones have presumed a fixed b - phosphate relationship. This allows the assumption that the effects of growth rate, and other physiological or environmental factors, on carbon isotopic fractionation can be minimized by analyzing sedimentary alkenones produced only in regions where phosphate concentrations can be constrained (e.g., Pagani et al., 2005). Unfortunately, the validity of that assumption is challenged by the results of this study, which suggest that the b - phosphate relationship suffers significant regional variations in the modern ocean and that measured growth rates do not vary systematically with phosphate concentration. This is not to say that the work of Pagani et al. (2005) and

others to use an alkenone-based proxy for paleo-pCO₂ are invalid. Indeed, there is nothing in this study to suggest that significant shifts qualitatively observed in the sedimentary alkenone do not correlate to concomitant shifts in paleo-pCO₂. Instead, failure to identify a global $b - \text{phosphate}$ relationship merely suggests that this proxy cannot yet be used to quantitatively determine paleo-pCO₂.

The inability of earlier photosynthetic carbon isotopic fractionation models to describe the results of this study highlights the difficulty of using ϵ_p as a proxy for CO₂ without first understanding the controls on carbon isotopic fractionation. To that end, the natural next step in this effort is to apply the recent model of Cassar et al. (2007) to the field data obtained in this study.