



Commentary: Evaluating the Role of Seagrass in Cenozoic CO₂ Variations

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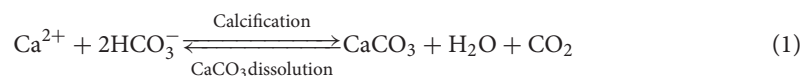
A commentary on

Evaluating the Role of Seagrass in Cenozoic CO₂ Variations

by Brandano, M., Cuffaro, M., Gaglianone, G., Pettricca, P., Stagno, V., and Mateu-Vicens, G. (2016). *Front. Environ. Sci.* 4:72. doi: 10.3389/fenvs.2016.00072

Brandano et al. (2016) sought to quantify the role of seagrasses in removing atmospheric CO₂ during the past 65 million years. To date, this estimate has been missing from the literature. Moreover, as the authors point out, there has so far been little attention paid to the role of calcium carbonate formation (CaCO₃; inorganic carbon precipitated by calcifying organisms) in seagrass carbon budgets; much of the literature has focused on organic carbon only. The authors conclude that seagrasses have had globally-significant impacts on atmospheric CO₂ fluxes throughout the Cenozoic era. While we appreciate the ambitious nature and difficulty of the study, we argue that the authors have made fundamental misconceptions about the contribution of carbonate production (calcification) and sequestration to ocean carbon budgets.

The authors have not accounted for the fact that calcification increases *p*CO₂ (by depleting CO₃²⁻ and therefore reducing alkalinity), which facilitates the return of CO₂ to the atmosphere (Frankignoulle et al., 1994). Specifically, for every mole of CaCO₃ precipitated as carbonate, the process also consumes 2 moles of HCO₃⁻ and releases 1 mole of CO₂:



However, the stoichiometry of this reaction is complicated by buffering effects in seawater (Frankignoulle et al., 1995), leading to less than 1 mole of CO₂ being released to the atmosphere. This ratio is ~0.63 under current atmospheric CO₂ concentrations (known as the “rule of the 0.6”; Ware et al., 1992), but is predicted to increase at higher atmospheric CO₂ concentrations (Suzuki, 1998), with unaddressed implications for the CO₂ atmospheric fluxes since the Cenozoic reported by Brandano et al. (2016) (their Figure 4). Hence, carbonate production results in CO₂ release, but the authors do not account for this. Instead, the authors treat carbonate production as resulting in net CO₂ sequestration, which they add to the CO₂ sink capacity of seagrasses, when in reality it needs to be treated as a CO₂ source.

Previous studies have pointed out that although *Posidonia* meadows (as well as other seagrass species; Mazarrasa et al., 2015) host significant CaCO₃ stocks and accumulation rates, it has been shown that calcification represents a global CO₂ source to the atmosphere

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(Smith and Gattuso, 2009), and therefore seagrass meadows (all species) could represent a significant net CO₂ source (Mateo and Serrano, 2012; Serrano et al., 2012). A global estimate for the entire Mediterranean indicates that calcification in *P. oceanica* meadows could be responsible for the emission of 0.7 to 4.2 Tg C year⁻¹ to the atmosphere (Mateo and Serrano, 2012). Indeed, they conclude that the net carbon balance between the organic carbon (CO₂ sink) and the inorganic carbon (CO₂ source) pools in Tyrrhenian *P. oceanica* meadows could range from -7.4 to +3.9 Tg C year⁻¹. Coral reefs are also not considered natural atmospheric CO₂ sinks because production and respiration are balanced (i.e., there is no net accumulation of organic carbon) and as a result of high calcification rates in many reef systems, they are considered a net source of CO₂ to the atmosphere (e.g., Ware et al., 1992; Gattuso et al., 1995).

We acknowledge the complexity of estimating the CO₂ sequestration capacity of ecosystems over geological time scales, and the multiple assumptions on which such type of estimates are based. However, we feel that their analysis is weakened

by not taking proper account of the chemistry of carbonate formation and that accordingly the values they report must represent an overestimate of the true rates of draw-down of CO₂.

AUTHOR CONTRIBUTIONS

PM led the paper. All authors contributed to the writing.

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