100% decomposition of diatomous organic carbon during settlement through ocean columns

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Introduction

Two major planktonic phases responsible for biological pump are diatoms and coccolithophores. In this study, diatom-frustule dominated settling particles was analyzed for the carbon isotopic ratio to evaluate the decomposition of diatom-derived organic carbon.

The samples of settling particles were collected from two stations in 200 km north and 300 km south of the Aleautian Islands using two sediment traps, which were deployed for one whole year (2008-2009). (1) Wet oxidation was employed to decompose non-refractory organic carbon (NRC) in the trapped samples. The CO_2 from NRC was analyzed for $\delta^{13}C$. (2) The residue of the wet oxidation was recovered as refractory carbon (RC) and the amount of RC was measured by an elemental analyzer.

Results and Discussion

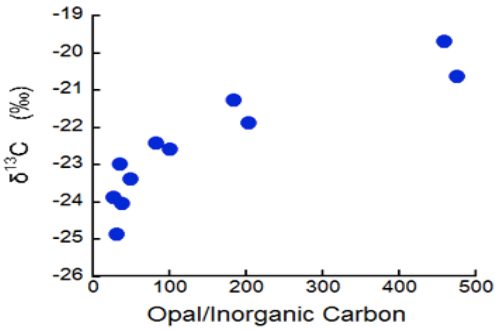

Figure 1: Relationship between $\delta^{13}C$ of NRC and Opal/Inorganic Carbon

(1) The relationship between carbon isotope ratio of NRC and Opal/Inorganic Carbon ratio is shown in Figure 1. Opal and inorganic carbon represents diatoms and coccolith+foraminifera, respectively. The carbon isotope ratio of the organic carbon in the settling particles was understood as a mixing of two end members with $\delta^{13}C$ of -19 ‰ and -25 ‰. The results of fitting suggest that the diatom-derived NRC has been almost totally decomposed.

(2) The amount of carbon recovered as RC was near the detection limit and RC was absent in most of the residue samples treated with the wet oxideation.

An insight into negative feedback mechanisms in a recovery phase of the PETM

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Across the Paleocene-Eocene boundary (PEB), an extreme global warming by 4-8 ºC coincided with a rapid and distinct negative carbon isotope excursion (CIE) in both marine and terrestrial environments, which is known as the Paleocene-Eocene Thermal Maximum (PETM). Several lines of evidence from previous studies strongly suggest that a massive and rapid injection of ^{13}C-depleted carbon into the ocean-atmosphere system induced the global carbon cycle perturbation and climate change. It is generally considered that, after the culmination of the global warming and CIE, enhanced continental chemical weathering and biological productivity functioned as negative feedbacks by which the excess carbon was removed from the ocean-atmosphere system.

We simulated the global carbon cycle perturbation across the PEB with a simple ocean-atmosphere box model modified from [1]. We calculated mass balances of carbon, calcium, and carbon isotopes regarding ocean and atmosphere boxes, which are connected by terrestrial weathering fluxes depending on atmospheric partial pressure of CO_2 and temperature. Earth system's negative feedbacks which appear to have worked in a recovery phase of the PETM correspond to variations of carbonate and organic carbon burial fluxes in the ocean box.

We compared our simulated results with geologic records from literatures. Our calculated organic carbon burial enhancement causes a transient positive shift in the oceanic carbon isotopes. However, to our knowledge, no such positive shift has been recognized during the PETM. A possible scenario that reconciles the simulated results with geologic records is a globally constant organic carbon burial in the ocean. While intensified continental weathering and nutrient-rich runoff may have resulted in elevated primary production on shelves, the open-ocean productivity decreased with the onset of the PETM [2]. Due to the balance of productivity changes between shelf and open-ocean environments, a global organic carbon burial flux in the ocean may have remained nearly constant across the PEB.

[1] Beerling & Berner (2002) *Global Biogeochem. Cycles*, **16**, 10.1029/2001GB001637. [2] Gibbs *et al.* (2006) *Geology*, **34**, 233-236.

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