Subseafloor storage of biogenic methane prior to the Paleocene-Eocene Thermal Maximum

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A better understanding of the size of carbon reservoirs during past hyperthermal events can provide deeper insights into Earth's carbon cycle and can help predict possible consequences of the anthropogenic carbon release. The Paleocene-Eocene Thermal Maximum (PETM, ~56 Ma) is one of the most intensively studied hyperthermals. Although various geochemical proxies and modeling studies have given constraints on the timing, duration and amount of the carbon release, the relative significances of different carbon sources (volcanic CO_2 and biogenic CH_4 in particular) are still disputable. To better constrain the contribution from methane produced by subsurface marine microbes, we estimate the size of the sediment methane gas hydrate inventory prior to the PETM by forcing an early diagenetic [1] and methane gas hydrate [2] model with Earth System Model output just prior to the PETM [3]. The calculations with plausible assumptions on the relevant physicochemical parameters (e.g., water flow rate) are conducted to suggest a possible range for the methane hydrate inventory. This estimate can lead to constraints not only on the biogenic methane release, but also on the volcanic carbon release, given a likely range of the carbon isotope signature of biogenic methane and the carbon isotope excursion during the PETM.

[1] Archer et al. (2002) Global Biogeochem. Cycles 16, 1.
[2] Davie and Buffett (2003) J. Geophys. Res. 108, B10.
[3] Ridgwell et al. (2007) Biogeosciences 4, 87-104.