Can fossil carbon reworking explain the sustained high CO_2 levels of the Paleocene-Eocene Thermal Maximum?

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Climate events in the geologic record can provide insight on Earth's responses to global warming on longer timescales than we can observe in the modern. The Paleocene-Eocene Thermal Maximum (PETM), an abrupt global warming event (~56 Myr ago) driven by a rapid and massive release of ^{13}C-depleted C to Earth's oceans and atmosphere, is often used to identify potential long-term impacts of anthropogenic climate change. The PETM is marked by deep-sea carbonate dissolution and a negative carbon isotope excursion (CIE) in globally distributed carbonate and organic carbon records. While the event was initiated by a quick (< 10 kyr) release of more than 4500 Pg C, Earth system models cannot reproduce the CIE, dissolution and maintined low $\delta^{13}C$ values without a sustained release of C for 10's of kyr after the initial climate perturbation.

We assessed sedimentary organic matter oxidation during transport from land to sea as a mechanism to sustain high atmospheric pCO_2 for tens of kyr, using PETM paleoshelf records from Mid-Atlantic US to reveal a dominance of transported fossil carbon. Results from biomarker thermal maturity ratios and carbon isotope mixing models indicate that fossil carbon transport from land to sea increased by a factor of 4 about 10-20 kyr after the onset of C release and its associated warming. Our results indicate 10^4-10^5 Pg of C was released, remobilized, and oxidized during the warming event. This amount is sufficient to explain both the PETM duration and the extent of seafloor carbonate sediment dissolution. Enhanced erosion, mobilization, and oxidation of fossil sedimentary carbon is a plausible Earth system response to hyperthermals that can delay recovery of the climate system for many thousands of years.