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A global perspective of Paleocene Eocene Thermal Maximum ocean deoxygenation from thallium isotopes

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The Paleocene Eocene Thermal Maximum (PETM) occurred ~56 million years ago [Ma] and is a hyperthermal with a rapid 5-9-degree Celsius warming alongside a massive carbon release that links to ocean acidification and rapid turnover in the ecosystem. Due to its similarities with today's changing climate, it is used as a potential analog for the future. The ocean deoxygenation that has been linked to this hyperthermal event is still highly debated due to limited ocean records from localized proxies and conflicting interpretations in different ocean basins, making it challenging to resolve the global ocean responses to the rapid warming [1]. The recently advanced thallium (Tl) isotope (ε^{205}Tl, normalized ^{205}Tl/^{203}Tl in parts per ten thousand) proxy permits us to reconstruct a globally integrated ocean oxygen record by tracking global manganese oxide burial [2]. Here we reconstructed bulk element and ε^{205}Tl records during PETM from the IODP Site U1557 (30.9411˚S, 26.6298˚W, 5012 m water depth), located in a deep subbasin in the western South Atlantic Ocean. Our results showed that the site experienced a sustained lower oxygenation with much lower manganese (Mn) concentrations during the peak of the hyperthermal. However, our ε^{205}Tl record only shows a rapid deoxygenation before the onset of PETM (defined by carbon isotopes), whereas the peak of PETM features a recovery of ocean oxygenation. We also observed gradual deoxygenation during the recovery stage, followed by a rapid reoxygenation near the end of the PETM recovery at Site U1557. The difference between ε^{205}Tl and local O_2 responses implies that the Tl isotope record should reflect a global deoxygenation trend independent from local oxygen controls (e.g., productivity and ventilation). Ongoing measurements of other Atlantic sites will allow us to further confirm this observation, providing more insights on global ocean oxygenation responses in PETM and its relationships with carbon perturbations.

References:

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[2] Wang, Y., Lu, W., Costa, K. M., & Nielsen, S. G. (2022), Geochim. Cosmochim. Acta 333, 347–361.