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Mercury (Hg) isotope evidence for enhanced importance of terrestrial Hg to the global ocean during the early Jurassic oceanic anoxic event (Toarcian OAE)

XINYUAN ZHENG[1], LAWRENCE PERCIVAL[2], RUNSHENG YIN[3], AISHA AL SUWAIDI[4], MARISA STORM[5,6], MICHA RUHL[7], WEIMU XU[8], STEPHEN P HESSELBO[9] AND HUGH C. JENKYNS[10]

[1]University of Minnesota - Twin Cities
[2]AMGC, Vrije Universiteit Brussel
[3]State Key Laboratory of Ore Deposit Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences
[4]Khalifa University of Science and Technology
[5]Royal Netherlands Institute for Sea Research
[6]Netherlands Earth Systems Science Centre (NESSC)
[7]Trinity College Dublin
[8]University College Dublin
[9]University of Exeter
[10]University of Oxford

Presenting Author: zhengxy@umn.edu

The early Toarcian oceanic anoxic event (T-OAE, ~183 Ma) was associated with widespread marine anoxia, high temperatures, significant biotic turnover, and major perturbations of the global carbon cycle. This event has been increasingly linked to emplacement of the Karoo and Ferrar Large Igneous Province. Widespread enrichments in mercury (Hg) concentrations or Hg/TOC ratios measured in marine sedimentary sequences recording the T-OAE have been taken as important evidence for volcanic eruptions [1]. However, a volcanic origin of the elevated Hg levels has not been thoroughly tested.

Here we present stable Hg-isotope results from three well-studied T-OAE sequences – the Hawsker Bottoms section and Mochras drill core from the UK, and a southern hemisphere section from Arroyo Lapa, Argentina. Measured δ^{202}Hg values (~ -2‰ to 0‰) are variable within and across individual sections, suggesting influence of local processes on mass-dependent fractionation of Hg isotopes. Interestingly, mass-independent fractionation (MIF) of odd Hg isotopes, Δ^{199}Hg, exhibits negative excursions reaching -0.2‰ to -0.4‰ over the T-OAE interval in all three sections. Such negative Δ^{199}Hg values are typical of Hg from terrestrial sources, rather than direct volcanogenic Hg carrying a Δ^{199}Hg signature of ~0‰. Even Hg-isotope MIF signatures, Δ^{200}Hg, imply reduced influence from the atmospheric Hg input relative to terrestrially-derived sources during intervals of negative Δ^{199}Hg excursions. For the Hawsker Bottoms and Mochras successions, where osmium (Os) isotope data are available, the negative Δ^{199}Hg excursions stratigraphically correlate with positive shifts in Os-isotope ratios. Combined with a negative Δ^{199}Hg excursion previously observed in a T-OAE section from Canada (NE Panthalassa) [2], our new results indicate enhanced influence of terrestrially-derived Hg in the global ocean during the T-OAE, which was likely associated with enhanced continental weathering in response to rapid climate warming during the event. Our results do not preclude the possibility that this terrestrial mercury was originally derived from volcanic emissions and subsequently shuttled to the ocean, but they highlight the need for an improved understanding of Hg transport pathways in ancient sediments when applying Hg as a tracer for volcanic activity.

[1] Percival et al., *EPSL* 428, 2015. [2] Them II et al., *EPSL* 507, 2019.