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Ocean anoxia did not cause the Latest Permian Extinction

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The Latest Permian Extinction (LPE, ∼252 million years ago) was a turning point in the history of life on Earth with a loss of ∼96% of all marine species and ∼70% of all terrestrial species. While, the event undoubtedly shaped the evolution of life its cause remains enigmatic. A leading hypothesis is that the global oceans became depleted in oxygen (anoxia). In order to test this hypothesis we investigated a proxy for marine oxygen levels (molybdenum isotopic composition) in shale across the LPE horizon located on the subtropical northwest margin of Pangea at that time. We studied two sedimentary records in the Sverdrup basin, Canadian High Arctic: Buchanan Lake (eastern Axel Heiberg Island; 79˚26.1´N, 87˚12.6´W), representing a distal deep-water slope environment, and West Blind Fiord (southwest Ellesmere Island; 78˚23.9´N, 85˚57.2´W), representing a deep outer shelf environment (below storm wave base).

The molybdenum isotopic composition ($\delta^{98/95}$Mo) of sediments has recently become a powerful tool as a paleo-oceanographic proxy of marine oxygen levels. Sample preparation was carried out in a metal-free clean room facility in the isotope laboratory of the Department of Physics and Astronomy, University of Calgary, Canada, that is supplied by HEPA-filtered air. Molybdenum isotope ratios were determined on a Thermo Scientific multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS) with an uncertainty better than ±0.10‰ for $\delta^{98/95}$Mo values.

Results from the Buchanan Lake section show a large shift in $\delta^{98/95}$Mo values from 2.02‰ to +2.23‰ at the extinction horizon, consistent with onset of euxinic conditions. In contrast, West Blind Fiord shales, representing the sub-storm wave base shelf environment, show little change in the molybdenum isotopic composition (1.34‰ to +0.05‰), indicating ongoing oxic conditions across the LPE (Proemse et al., 2013).

Our results suggest that areas of the Pangea continental shelf (North West Pangea) experienced oxic conditions throughout the LPE event, while anoxic conditions developed in the deep ocean. Hence, anoxic marine waters did not extend globally onto shelf environments and as such ocean anoxia cannot have been the main driver of the extinction event. While global systems were stressed by anoxia, the anoxic conditions may better represent a symptom of Siberian Trap eruptions that had catastrophic impact on the environment, potentially through nutrient loading and deposition of toxic substances into marine and terrestrial systems.

Proemse et al., 2013: Molybdenum isotopic evidence for oxic marine conditions during the latest Permian extinction. Geology 41, 967-970.