Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31489

The Ireviken Oceanic Anoxic Event documented by hexavalent uranium isotopes

ZHENGFU ZHAO[1], BRAD CRAMER[2], MARIANO REMÍREZ[3], ALEXANDER J. DICKSON[4] AND **TAIS W. DAHL**[5]

[1]PetroChina
[2]University of Iowa, USA
[3]George Mason University
[4]Royal Holloway University of London
[5]University of Copenhagen

Prolonged periods of low marine oxygen levels have significantly influenced ocean chemistry and biological evolution, often coinciding with global warming. However, we document an Oceanic Anoxic Event (OAE) that induced global cooling during Wenlock Epoch of the Silurian Period (~432-429 Ma) by analyzing the marine carbon and uranium cycles during the Ireviken event. We introduce a novel anaerobic extraction method to reconstruct the uranium isotope composition of ancient seawater, revealing a substantial negative shift from –0.3‰ to -0.8‰ in hexavalent uranium extracted from marine carbonates in the Altajme drill core, Sweden.

This shift coincides with the +3-4‰ positive Ireviken carbon isotope excursion, with a larger uranium isotope excursion in hexavalent uranium (–0.45‰) than in total carbonate-associated uranium (–0.30‰). The presence of diagenetic tetravalent uranium with a heavier isotope signature suggest contamination in carbonate-associated uranium, whereas hexavalent uranium likely preserves the original seawater signal, indicating minimal post-depositional oxidation in our procedure. The results demonstrate that hexavalent uranium isotopes provide a powerful new tool for reconstructing global ocean redox conditions from the marine carbonate record.

Our combined uranium and carbon isotope data suggest that the Ireviken biogeochemical event was characterized by elevated biological production, enhanced organic carbon burial and widespread marine oxygen loss. Unlike OAEs associated with hyperthermal events, the Ireviken OAE induced global cooling and persisted through multiple sea-level cycles. We propose that ocean fertilization drove anoxia, outpacing the cooling-induced increase in oxygen solubility and ocean ventilation. These findings provide key insights into the interplay of climate, carbon cycling and ocean redox dynamics, offering a framework to assess the controls on atmospheric CO_2 removal and marine oxygen loss in the Earth System.