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Oceanic deoxygenation during the mid-Silurian Ireviken Extinction Event

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The landovery-Wenlock transition during the Silurian Period was a pivotal phase marked by significant marine environmental evolution and biotic turnover, culminating in the Ireviken Extinction Event (IEE) and the Early Sheinwoodian Carbon Isotope Excursion (ESCIE). Published geochemical evidence suggests a simultaneous expansion of euxinic waters along continental margins, consistent with the observed carbon cycle perturbation during the IEE. The development of oceanic anoxia precipitated a crisis in marine ecosystems, reflecting a recurrent scenario during the Silurian.

Here, we present an investigation of a major Silurian anoxic event associated with the IEE, employing a diverse geochemical dataset and modelling approach. Four field sections across the Llandovery-Wenlock boundary in England and Wales, representing varying water depths, were selected. Utilizing C-S-Fe systematics, redox sensitive trace metals and elemental weathering proxies, alongside sedimentological and stratigraphic paleontological evidence, we reconstructed the regional redox evolution of this basin. We then utilized U and Mo isotopes, in conjunction with a newly developed U-Mo isotope fractionation model, to reconstruct global redox variability during this period.

Our findings suggest that the Silurian Telychian ocean experienced significant oxygenation under warm climatic conditions after the Hirnantian glaciation, approaching the degree of oxygenation of modern oceans. However, a subsequent shift to colder climatic conditions likely intensified ocean circulation, resulting in upwelling of deeper nutrient-rich waters onto the shelf. Consequently, the global ocean transitioned to an expanded state of ferruginous anoxia. This process particularly facilitated regional anoxia in shallower shelf settings during the IEE, which triggered the global carbon and sulfur isotope excursion and biotic crisis. Our study highlights the complex interplay between climate dynamics, ocean circulation, and biogeochemical processes during the Silurian, shedding light on the mechanisms driving major environmental and biotic change in the mid-Palaeozoic.