

Zinc isotopic evidence for enhanced oceanic primary productivity during termination of the late Ediacaran Shuram Excursion

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The recovery from the largest negative carbon isotope ($\delta^{13}\text{C}$) excursion in Earth history, the late Ediacaran Shuram Excursion, is thought to have been related to enhanced primary productivity, but direct evidence is lacking. The Zn isotopic composition ($\delta^{66}\text{Zn}$) of marine sediments is a promising proxy to constrain oceanic productivity as well as organic matter burial rates. In this study, we measured $\delta^{66}\text{Zn}$, major- and trace-element, and iron speciation for black shales from Member IV of the Ediacaran Doushantuo Formation in the Jiulongwan and ZK 6305 sections of South China. Redox data reveal predominantly euxinic bottom waters, and salinity data indicate mostly high-brackish conditions (~15-30 psu) linked to moderate basinal watermass restriction. This black shale succession may have preserved contemporaneous seawater $\delta^{66}\text{Zn}$ compositions, recording positive excursions from +0.31‰ to +0.70‰ at JLW and from +0.35‰ to +0.62‰ at ZK6305. These results provide direct evidence for elevated oceanic productivity and enhanced organic matter burial during the recovery from the Shuram Excursion. Moreover, they imply that enhanced organic burial, which removed isotopically light carbon from the ocean, not only led to recovery from the Shuram Excursion but also resulted in re-coupling of the carbonate and organic $\delta^{13}\text{C}$ records by elevating the relative proportion of particulate organic carbon relative to dissolved organic carbon in the sediment. Our study confirms the critical role of oceanic productivity in attenuating perturbations of the marine carbon cycle.