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Seawater sulphur isotope variations from the Tarim Basin during the Cambrian Series 2–3: implications for causes of the ROECE event

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The first trilobite mass extinction, known as the *Redlichiid–Olenellid* Extinction, occurred at the Cambrian Series 2–3 boundary and is associated with the *Redlichiid–Olenellid* Extinction Carbon Isotope Excursion (ROECE). The causes of the ROECE event remain debated, with some researchers attributing it to Kalkarindji volcanism and others linking it to a coeval large-scale transgression event. Continuous seawater sulphur isotope records across this boundary are crucial for resolving this debate.

In this study, we present sulphur isotope data from carbonate-associated sulphate (CAS) across the Cambrian Series 2–3 boundary, obtained from the Xiaoerbrak section in the Tarim Basin. Using these data, we reconstruct a seawater $\delta^{34}S$ variation curve for this critical period. Our findings reveal that seawater $\delta^{34}S$ values were likely positively coupled with $\delta^{13}C$ values during Cambrian Series 2 and an abrupt increase in $\delta^{34}S$ occurred across the Cambrian Series 2–3 boundary, marking a shift from coupled to decoupled carbon-sulphur isotope behaviour.

According to the prevailing ROECE hypothesis, this decoupling of carbon and sulphur isotopes may have been driven by significant inputs of light carbon, either from Kalkarindji volcanism or from anoxic bottom waters. To test these hypotheses, we employed a biogeochemical box model. The modelling results indicate that light carbon emissions from volcanism do not align with the observed seawater isotope variations. Instead, the data are best explained by the dissolved organic carbon (DOC) oxidation hypothesis, an updated version of the anoxic bottom water shoaling/upwelling hypothesis.

This hypothesis proposes that DOC-enriched anoxic bottom waters were oxidized by oxygen during a large-scale transgression, leading to negative seawater $\delta^{13}C$ excursions. Concurrently, expanded anoxia and increased pyrite burial caused a sharp rise in seawater $\delta^{34}S$ at the Cambrian Series 2–3 boundary. The DOC oxidation hypothesis effectively accounts for the decoupled carbon and sulphur isotope behaviours during this period and underscores the critical role of reduced oxygen levels in driving the *Redlichiid–Olenellid* Extinction.