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Reexamination and reidentification of ocean oxygenation event in the wake of the Marinoan glaciation

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The earliest Ediacaran oceanic oxygenation event, defined as OOE-A (~635–632 Ma) following the Marinoan glaciation, represents a crucial component of the Neoproterozoic Oxygenation Event. This event was primarily identified based on high enrichments of redox-sensitive elements (RSEs) in the basal Ediacaran Doushantuo Formation of South China. However, its robustness on a global scale has been subject to debate. In this study, we reexamine the proposed OOE-A through an integrative analysis of correlative successions across the shelf-to-basin transect in South China, alongside records from other continents. Sedimentary and geochemical evidence, including iron speciation, RSEs, $\delta^{13}C_{org}$, and $\delta^{34}S_{py}$, collectively indicate an oxic shelf and an anoxic (intermittently euxinic) basin, with a fluctuating chemocline around the upper slope setting in South China. Meanwhile, utilizing a diffusion-reaction model that takes sedimentation rate and authigenic RSE concentration into consideration, we reconcile the disparities in RSE enrichment levels observed in the basal Ediacaran black shales between South China and northwestern Canada. The results suggest that these discrepancies can be attributed to low seawater Mo (0.5–3 nM) and U (0.2–0.8 nM) concentrations, challenging the conventional perspective of the expansion of seawater RSE reservoirs due to a widely ocean oxygenation, while highlighting a significant role of slow sedimentation rates in driving authigenic RSE enrichments in anoxic marine facies locally. From both spatial and temporal perspectives, this study refines the magnitude of OOE-A in South China, characterizing it as a transient oxygenated shelf environment within a redox-stratified ocean. The reexamination of OOE-A provides new insights into other documented oceanic oxygenation events and the intricate relationship between marine oxygenation and biological evolution during the Neoproterozoic Oxygenation Event.