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The redox states of open ocean during the early Ediacaran and early Cambrian: constraints from vanadium isotopes

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The marine redox states during the early Ediacaran and Cambrian Age 1–3 and their relationships with biological evolution are highly debated. Sedimentary vanadium (V) isotope records are an emerging redox proxy with the ability to trace rapid and subtle changes in global marine redox state. In this study, we report V isotope compositions ($\delta^{51}V$) of marine fine-grained siliciclastic rocks from the lower Ediacaran and Cambrian Stage 1–3 successions in the Yangtze Block, South China. The $\delta^{51}V$ variation in the lower Ediacaran succession was caused by local V drawdown efficiency, while that of the Cambrian Stage 1–3 was derived from the open-ocean seawater $\delta^{51}V$ ($\delta^{51}V_{OSW}$) variation in response to global marine redox change. Based on these sedimentary $\delta^{51}V$ records, we reconstructed temporary $\delta^{51}V_{OSW}$ variations during the early Ediacaran and Cambrian Age 1–3. The results suggest that the early Ediacaran (ca. 594–580 Ma) open ocean was extensively euxinic, in which the early organisms could survive due to the low oxygen requirements for basic metabolism or local oceanic oxygenation. The open ocean during Cambrian Age 1–3 (ca. 539–514 Ma) was dominated by oxic seafloor area, especially reaching the modern level at ca. 521 Ma, which may have promoted the first appearance and radiation of skeletal metazoans and the subsequent Cambrian Explosion.