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Lithium isotopes reveal enhanced reverse weathering post-Late Ordovician mass extinction

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The Ordovician–Silurian transition (OST) comprised two non-glacial intervals (the Katian and Rhuddanian) separated by the Hirnantian glaciation, recording the first of the 'Big Five' Phanerozoic mass extinctions (ca. 445 Ma). While such dramatic climate change is tightly coupled to shifts between continental weathering and reverse weathering regimes, the mechanisms behind the extreme conditions remain elusive. Particularly, the drivers of late Ordovician CO_2 drawdown and early Silurian climate recovery are poorly constrained. Here, we report high-resolution lithium isotope (δ^7Li) and trace element data from marine shales spanning the Late Ordovician mass extinction (LOME). Our data reveal a ~17‰ positive excursion in post-LOME shales, a trend that aligns with the existing carbonate-based seawater δ^7Li reconstruction. This congruence signals a major perturbation in the global lithium cycle. Coupling Monte Carlo modeling with petrographic observations of siliceous microfossil-clay mineral symbiosis, we demonstrate that a substantial increase in marine clay Li uptake is required to account for the observed δ^7Li trends in post-LOME shales (~444–443.5 Ma). Intensified reverse weathering may have facilitated post-LOME biotic recovery via both CO_2-induced warming and ocean pH stabilization. Together, our findings provide robust evidence that enhanced reverse weathering occurred following the Earth's first mass extinction, a process that has been previously overlooked.