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Intense global continental weathering drove the Ediacaran Shuram Excursion

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The Ediacaran Shuram Excursion (SE) preserved globally in shallow marine carbonates represents a pivotal carbon cycle anomaly that aligns with significant tectonic and evolutionary events, including Pan-African orogenesis and the first appearance of multicellular animals associated with the Ediacara biota. While the driving mechanism(s) of the SE are debated, our integrated study supports the view that a marked increase in continental weathering associated with widespread mountain building and high pCO_2 resulted in the oxidation of a ^{12}C-rich oceanic dissolved organic carbon pool. We utilize lithium isotope measurements from SE carbonates in central Siberia and its equivalent in South China to assess the intensity and nature of the global continental weathering flux during the oceanographic phenomenon. Our results indicate near crustal δ^7Li values (~3–5‰) in SE carbonates, in stark contrast to modern marine carbonate δ^7Li values (>20‰). This observation suggests that the SE was driven by intense congruent continental weathering that delivered river water to the global ocean with extremely low δ^7Li composition, as well as muted fractionation of lithium isotopes associated with the rapid formation of marine clays due to high oceanic silica concentrations. Enhanced continental weathering would have increased the fluxes of nutrients, dissolved ions, and oxidants to the oceans that facilitated primary productivity, an increase in the carbonate saturation state that promoted the rapid deposition of carbonates (potentially setting the stage for carbonate biomineralization), and seawater ventilation (as reflected in δ^{238}U compositions of SE carbonates worldwide). The buildup of photosynthetic oxygen may have been promoted by the metabolic activities of sponge-grade animals – the remains of which are preserved in SE carbonates of Siberia, South Australia, and Namibia. These findings suggest that intensified continental weathering during the SE profoundly affected ocean chemistry, thereby catalyzing Ediacaran biological transitions and ecosystem evolution.