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How did phosphorus cycling shape oxygen and early animal evolution in the Ediacaran?

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Phosphorus is a limiting nutrient that is thought to control oceanic oxygen levels to a large extent. A possible increase in marine phosphorus concentrations during the Ediacaran Period (~635-539 Myr) has been proposed as a driver for increasing oxygen levels. Little is known, however, about the nature and evolution of phosphorus cycling during this time. To address this we applied the carbonate-associated phosphate (CAP) proxy to six globally-distributed sections to reconstruct oceanic phosphorous concentrations during a large negative carbon isotope excursion – the Shuram Excursion (SE), which co-occurred with global oceanic oxygenation. Using a quantitative biogeochemical model our CAP data suggest equivalent ocean phosphorus concentrations under maximum and minimum extents of ocean anoxia across the SE. This observation may reflect decoupled phosphorus and ocean anoxia cycles, as opposed to their coupled nature in the modern ocean. Our findings point to external stimuli such as weathering events rather than internal oceanic phosphorus-oxygen cycling alone as a control on oceanic oxygenation in the Ediacaran, which in turn may help explain the prolonged rise of atmospheric oxygen levels across the Precambrian.