

## Acid weathering, clay transport and enhanced phosphate supply to Early Paleoproterozoic oceans following the Great Oxidation Event

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It was previously hypothesized that following the Great Oxidation Event at ca. 2.5 billion years ago, oxygenation of the atmosphere led to unprecedented acid production from biological oxidation of crustal pyrite, leading to enhanced levels of nutrient transport to the oceans. Higher levels of terrestrial phosphate supply would then have facilitated marine primary production, the burial of more organic carbon than any previous time in Earth's history, a rise in atmospheric oxygen, and a large increase in the  $\delta^{13}\text{C}$  value of marine carbonates; these events are collectively known as the Lomagundi Event (LE) between ca. 2.22 and 2.06 Ga. Although phosphate was initially sourced from dissolution of crustal pyrite by acidic soil pore- and ground-waters, the mechanisms by which the phosphate was transported to the oceans and then concentrated into P-rich deposits is unclear. Here we show that phosphate is readily adsorbed onto kaolinite particles under freshwater conditions (pH 6, ionic strength=0.01 M) but that phosphate is released in marine aquatic environments (pH 8, ionic strength=0.56 M). Phosphate sorption is increased 94% when the pH is further dropped to pH 4, conditions mimicking acid rock drainage. We suggest that during post-GOE terrestrial weathering, P was carried by suspended clay particles to estuarine environments, where P was desorbed, released into seawater as ionic phosphate species and then utilized by photosynthetic plankton. Our research provides new perspectives on the mechanisms that link the rise in atmospheric  $\text{O}_2$  with the evolution of aerobic chemoautotrophy on land to the LE.