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High productivity prior to the Great Oxidation Event: Insights from Archean and Paleoproterozoic Banded Iron Formations of India

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Phosphorous (P)—a key bio-limiting nutrient—plays an important role in shaping the Earth's ocean-atmosphere landscape. Despite our understanding of P in Phanerozoic systems, the role P played in Precambrian ecosystems and early life is still poorly understood. Recent studies suggest that the molar ratio of P/Fe, expressed as (P/Fe x 100), is a good proxy for the first-order approximation of seawater P concentration. A key criterion for this proxy is based on iron-rich rocks, particularly banded iron formations (BIFs). Despite the prevalence of BIFs across the Indian subcontinent, no such data has been used to understand deep time. Here, we present new data and literature compilations of P/Fe from 12 formations sampled from five cratons in India that span between the Eoarchean and Paleoproterozoic eras. The bulk rock P/Fe ratio of the Archean BIFs range between 0.018 and 1.23, and in the late Paleoproterozoic BIFs, they range between 0.515 and 0.618. Modeled seawater P concentrations range between 0.001 and 0.280 μM, based on a narrow range of Si concentrations (0—0.67 mM) during the Archean and Proterozoic oceans. Although Archean and Paleoproterozoic seawater are generally low in P concentrations, we record a spike in P/Fe molar ratio (1.123) in ferruginous chert right before the Great Oxidation Event (GOE), suggesting higher seawater P concentrations and thus higher productivity. Despite our limited dataset, our results provide insight into an important time period and expand our understanding of the onset of the GOE. Overall, our study support the idea that low P concentrations in seawater during the Archean and Proterozoic threatened the evolution of early life; however, these results open an avenue to explore primary productivity before the GOE.