

Reconstructing phosphorus bioavailability and cycling in ancient marine environments: Insight from the Devonian Ningxiang Iron Deposits

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Abstract

Phosphorus is an ultimate limiting nutrient for primary producers over geological timescales and hence regulates organic carbon burial and ultimately oxygen production (e.g., Bjerrum and Canfield, 2002; Reinhard et al., 2017; Alcott et al., 2022). Iron-rich chemical sediments are widely used to reflect contemporaneous seawater phosphate concentrations (e.g., Bjerrum and Canfield, 2002; Konhauser et al., 2007; Jones et al., 2015). However, the precision of these estimates is impacted by numerous factors, including iron mineralogy (e.g., Konhauser et al., 2007), chemical composition of seawater (Jones et al., 2015), and subsequent phosphorus cycling (Alcott et al., 2022). To provide further insight into phosphorus sequestration in iron-rich sediments, we present a detailed petrological, mineralogical and geochemical study of phosphorus dynamics in the Late Devonian Ningxiang ironstones from South China. Application of sequential phosphorus extractions and spectroscopy provides detailed insight into the phase partitioning of phosphorus, highlighting transformation of original Fe (oxyhydr)oxide-bound phosphorus to authigenic phosphorus during diagenesis. In addition, spectroscopic observations demonstrate that Al minerals are a significant host for phosphorus. In general, diagenetic transformation between different phosphorus pools has proven to be challenging when reconstructing ancient marine phosphorus concentrations from iron-rich sediments, and we suggest that phosphorus phase partitioning analyses provide critical insight that may ultimately allow a more rigorous estimation of dissolved phosphorus concentrations in ancient seawater.

References:

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