Phosphogenesis in the Ediacaran Doushantuo Basin, south China

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The Ediacaran Doushantuo Formation (635-551 Ma) in the northeastern Yangtze Craton, South China, preserves a wealth of sedimentological, microstructural, biological and geochemical data that shed light on the unprecedented phosphogenic events in the terminal Proterozoic. It is characterized by a black shale-phosphorite-carbonate sequence that deposited mainly in sub-tidal to supra-tidal environments within a restricted basin. A variety of biogenic structures characterize the most P-rich horizons (P_2O_5 up to 38 wt%), including stromatolites dominated by stratiform and wavy form, decimeter to sub-minimeter sized oncoids, and peloids. Optical microscopy and Raman microspectroscopy reveals the presence of abundant cyanobacteria-like microfossils in these structures. Ce anomalies of the phosphorites are variable but show a general decrease from ca. 1.0 to 0.6, suggesting overall anoxic to suboxic conditions and an increase in the redox potential of the seawater. Pyrite framboids are generally absent in the most P-rich layers but are abundant in organic-rich chert or carbonate. The small mean diameters (3.0-4.5μm) and maximum diameters (6.7-9.3 μm) of the framboids document the prevalence of dysoxic bottom waters in Doushantuo Basin, which might have facilitated phosphogenesis. These P-rich horizons pinch out toward deeper water environments in the South where euxinic conditions might have prevailed, as evaluated from higher sulphide concentrations. $\delta^{13}C$ of the carbonates range between -6.1 and +5.2 ‰ V-PDB, whereas co-existing phosphorites generally have lighter $\delta^{13}C$ (-8.4 to +1.1 ‰V-PDB), consistent with the profound perturbations of marine C cycles tied to redox fluctuations and incorporation of remineralized organic matter during phosphogenesis. The data suggest that microbially-mediated and Fe-redox pumping of phosphorus near the chemocline probably played fundamental roles in phosphogenesis. Communities of diverse microorgnisms, including cyanobacteria and sulfur metabolizing bacteria might have worked in concert to promote the cycling of phosphorus and mass production of phosphorite in the Doushantuo Basin.