Precambrian phosphorus scarcity and early Earth evolution

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As a key nutrient required for growth, the availability of phosphorus regulates biological production and the overall activity of the biosphere over geologic time scales. Iron oxides represent a major sink for phosphorus in the well oxygenated modern oceans [1]. Unlike today, however, the deep oceans of the Precambrian Eons were anoxic and ferrous iron rich (ferruginous) [2]. Oxidative precipitation and sedimentation of this Fe would have represented an enormous marine phosporus sink, notably during times of Banded Iron Formation deposition [3]. Reconstruction of seawater chemistry through time reveals deep ocean phosphorus concentrations of 0.04 to 0.13 μM throughout the Precambrian Eons—a mere fraction of those in the modern deep ocean (~3 μM) [4]. Such low phophorus concentrations would have constrained rates of global biological productivity during intervals characterized by ferrugiouus ocean conditions. Furthermore, nutrient dynamics would likely have favored growth of anoxygenic phototrophs over oxygenic phototrophs suggesting that the low phosphorus concentrations of the Precambrian oceans may have delayed the proliferation of cyanobacteria and the oxygenation of the ocean-atmosphere system. Here we further explore these relationships and in particular highlight the possible role of photoferrophy in the evolution of Earth surface chemistry during the Precambrian.

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