Photosynthetic oxidation of the Earth before cyanobacteria

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Photoferrotrophs use light energy to oxidize ferrous iron to ferric iron and convert carbon dioxide into cellular biomass. Models for the deposition of Precambrian Banded Iron Formations (BIF) implicate photoferrotrophy as the primary source of ferric iron [1,2], but the fate of biomass remains enigmatic—BIFs are conspicuously poor in organic carbon despite the common association of ferric iron with cell biomass. We show that in silica-rich seawater, pelagic photoferrotrophs shed ferric iron, physically separating it from biomass. Modeling of ocean upwelling systems demonstrates how this separation leads to depositon of carbon poor BIF, with biomass export to the open ocean. In the open ocean, and in the absence of sulfate, this biomass would fuel fermentation and methanogenesis supporting strong methane fluxes to the atmosphere which, through atmospheric photochemical methane oxidation, ultimately causes hydrogen loss to space [3]. Photoferrotrophs could thus have supported a methane-rich greenhouse atmosphere and the Earth's oxidation before large-scale cyanobacterial oxygen production.

[1] Konhauser et al. (2002) *Geology*, **30**, 1079–1082. [2] Kappler et al. (2005) *Geology*, **33**, 865-868. [3] Catling et al. (2001) *Sceince*, **293**, 839-843