Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16258

Microbial competition for iron in the Southern Ocean

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There has been a disproportionate focus on the role of 'new' iron (Fe) sources (e.g., terrestrial and hydrothermal inputs) in marine biogeochemistry. In contrast, the role of recycled Fe is understudied despite evidence that a large fraction of Fe is supplied by regeneration through the 'ferrous wheel', which is comprised of the key players in the microbial food web (bacteria, phytoplankton, and their consumers). Regenerated Fe is of consequence in biogeochemical models but there is a dearth of data to improve parameterizations. Here, we break into the 'black box' of the ferrous wheel by exploring the relative rates of Fe and carbon (C) uptake by heterotrophic bacteria and phytoplankton. To this end, we conducted field bioassays in subantarctic waters in which we removed bacteria from the 'ferrous wheel' by pre-incubation size fractionation. Previous experiments in the subantarctic show that small cells (<2 μm diameter) take up the most Fe, but this size class is a mix of heterotrophic bacteria and phytoplankton that compete for this limiting resource. Therefore, we sought to answer the question: how much Fe do heterotrophic bacteria take up compared to phytoplankton? In addition, the observation of seasonal differences in the shape of the depth profiles of Fe and C uptake led us to ask: how does light affect Fe and C uptake in both bacteria and phytoplankton?

We observed that picoeukaryotic phytoplankton took up Fe 2-fold faster than heterotrophic bacteria, while larger phytoplankton took up Fe at the slowest rates. When normalized to C biomass, the rates of Fe and C uptake by picoeukaryotes were 10-fold faster than heterotrophic bacteria, but the Fe:C uptake ratios of the two groups were nearly identical. The most striking result was the 8- to 16-fold increase in Fe uptake by phytoplankton, and the 4- to 8-fold increase by heterotrophic bacteria, in the light versus the dark. We discuss the implications of our findings for understanding how the ferrous wheel functions over the diurnal cycle, with depth, and seasonally.