Element stoichiometries of individual plankton cells collected during the Southern Ocean Iron Experiment (SOFeX)

Twining, Benjamin S., Stephen B. Baines, Nicholas S. Fisher

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ABSTRACT: During the Southern Ocean Iron Experiment (SOFeX), we analyzed Si, P, S, Mn, Ni, and Zn in individual diatoms, autotrophic flagellates, and heterotrophic flagellates with synchrotron-based X-ray fluorescence (SXRF) and calculated cellular C from measurements of cell size. Element stoichiometries for the different types of protists (normalized to either C, S, or P) were generally in good agreement with prior bulk analyses of natural assemblages but also revealed previously undocumented differences in elemental composition among cell types. Flagellated cells contained 39% more P than diatoms, which in turn contained 79% more Mn, 3-fold more Ni, and 2.6-fold more Zn than flagellates. Heterotroph cells contained approximately 40% more P and twice as much Zn as autotrophs. Manganese and Ni stoichiometries were negatively related to cell volume, while larger cells contained more Zn per mole C. Iron fertilization resulted in an approximate doubling of Mn, Ni, and Zn quotas and smaller increases in cellular P, but the timing of the stoichiometric changes varied between the two patches. Silicon contents of diatoms dropped approximately 40% after the first Fe addition but returned to prefertilization levels as cellular P doubled following the second addition, resulting in 40% lower Si : P ratios in the fertilized waters. The mean elemental stoichiometries calculated for all cells analyzed were comparable with previously published extended Redfield ratios for mixed plankton assemblages, but the observed differences between diatoms and flagellates and between autotrophs and heterotrophs indicate that valuable information is lost when all types of co-occurring plankton are grouped together for analysis.