Contrasting biogeochemistry of six trace metals during the rise and decay of a spring phytoplankton bloom in San Francisco Bay

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ABSTRACT: The spring 2003 phytoplankton bloom in South San Francisco Bay (South Bay) affected the cycling of Mn, Co, Zn, Ni, and Pb, but not Cu. We followed this diatom bloom for 2 months, capturing a peak in chlorophyll a (Chl a) of >150 $\mu g\ L^{-1}$ and then an increase in dissolved organic carbon of >400 $\mu mol\ L^{-1}$ as phytoplankton decomposed. To determine how the stages of the bloom affected metal concentrations, we used principal component analysis to reduce our 15 water chemistry variables into a bloom factor, a sorbent factor, and a decay factor. Increasing values of the bloom factor, which was a composite of dissolved oxygen, Chl a, and other variables, significantly accounted for reductions in dissolved Mn, Ni, and Pb. We attributed those declines to microbial oxidation, phytoplankton uptake, and sorption onto phytoplankton, respectively. In contrast, dissolved Cu concentrations were not explained by either the bloom or decay factors, consistent with previous studies showing its strong organic complexation and limited bioavailability in South Bay. The decay factor significantly accounted for increases in dissolved Mn, Co, Zn, and Pb. Decomposing bloom material presumably caused suboxic conditions in surface sediments, resulting in release of metals to overlying waters during reductive dissolution of Mn and Fe (hydr) oxides. These alterations in metal cycling during a nutrient-enriched bloom were evidence of eutrophication. Annually, phytoplankton productivity has the potential to affect metal retention in the estuary; in 2003, 75% of Ni discharged into lower South Bay by wastewater treatment plants was cycled through phytoplankton.

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