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Effects of dissolved carbon dioxide, zinc, and manganese on the cadmium to phosphorus ratio in natural phytoplankton assemblages

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ABSTRACT: We report the results of a field study, in productive waters off California, of the factors that control the particulate cadmium (Cd) : phosphorus (P) composition of natural assemblages of marine phytoplankton, the dominant vector of both elements to the deep ocean. Controlled shipboard incubation experiments (~2-4 d) demonstrated that while manipulation of pCO, and dissolved zinc (Zn) and manganese (Mn) concentrations had little effect on the species composition or C: nitrogen (N): P ratios of natural, diatom-dominated phytoplankton assemblages, their Cd : P ratio was negatively correlated to each of these variables. The particulate Cd: P ratios of phytoplankton were two to five times higher for cells grown at low pCO, than for cells acclimated to growth at pCO, at or above atmospheric equilibrium values. Addition of Zn to incubations at five- to 20-fold above background concentrations decreased Cd uptake and phytoplankton Cd: P ratios across pCO, and Mn treatments and suppressed short term Cd uptake rates by a factor of approximately two to four, compared to controls. A broad pattern of Mn suppression of Cd uptake was also evident in our incubations. We propose that natural variability in surface water pCO, and dissolved Zn and Mn, related to water mass history and biological drawdown, likely govern the degree of Cd uptake and, therefore, the evolution of the dissolved Cd : PO_ ratio in recently upwelled, high-productivity surface waters.

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