Iron and zinc enrichments in the northeastern subarctic Pacific: Ligand production and zinc availability in response to phytoplankton growth

Lohan, Maeve C., David W. Crawford, Duncan A. Purdie, Peter J. Statham

Limnol. Oceanogr., 50(5), 2005, 1427-1437 | DOI: 10.4319/lo.2005.50.5.1427

ABSTRACT: Iron- and zinc-enrichment experiments were carried out at Ocean Station Papa in the subarctic North Pacific. In iron-enriched treatments, phytoplankton chlorophyll *a* (Chl *a*) increased 20-fold (9.7 μg L^{-1}) above the concentration on day zero. No stimulation of Chl *a* production or nitrate drawdown was observed on addition of zinc alone compared to the control. In the iron-enriched treatment, bioavailable zinc concentration decreased to 0.2 pmol L^{-1} lower than that which is known in culture experiments to limit some phytoplankton growth. Theoretical analyses suggest that this zinc concentration would cause diffusion-limited growth of large diatom cells present at the end of the incubation. Direct measurements of zinc-binding ligands indicate that the natural microbial planktonic assemblages have the ability to respond rapidly to conditions of high dissolved zinc concentrations. Rapid ligand production may be a mechanism by which certain phytoplankton reduce zinc toxicity or for maintaining zinc concentrations in the upper water column. Zinc-binding ligands were observed to be both produced and removed on the timescale of 1 d. We suggest that these zinc-binding ligands are produced to assist assimilation, particularly under iron-enriched conditions when concentrations of bioavailable zinc were extremely low, thereby alleviating the effects of zinc limitation.