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Selenium Uptake and Volatilization by Marine Algae

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Selenium (Se) is an essential trace nutrient for humans. An estimated one half to one billion people worldwide suffer from Se deficiency, which is due to low concentrations and bioavailability of Se in soils where crops are grown. It has been hypothesized that more than half of the atmospheric Se deposition to soils is derived from the marine system, where microorganisms methylate and volatilize Se. Based on model results from the late 1980s, the atmospheric flux of these biogenic volatile Se compounds is around 9 Gt/year, with two thirds coming from the marine biosphere.

Algae, fungi, and bacteria are known to methylate Se. Although algal Se uptake, metabolism, and methylation influence the speciation and bioavailability of Se in the oceans, these processes have not been quantified under environmentally relevant conditions and are likely to differ among organisms. Therefore, we are investigating the uptake and methylation of the two main inorganic Se species (selenate and selenite) by three globally relevant microalgae: *Phaeocystis globosa*, the coccolithophorid *Emiliania huxleyi*, and the diatom *Thalassiosira oceanica*.

Selenium uptake and methylation were quantified in a batch experiment, where parallel gas-tight microcosms in a climate chamber were coupled to a gas-trapping system. For *E. huxleyi*, selenite uptake was strongly dependent on aqueous phosphate concentrations, which agrees with prior evidence that selenite uptake by phosphate transporters is a significant Se source for marine algae. Selenate uptake was much lower than selenite uptake. The most important volatile Se compounds produced were dimethyl selenide, dimethyl diselenide, and dimethyl selenyl sulfide. Production rates of volatile Se species were larger with increasing intracellular Se concentration and in the decline phase of the alga. Similar experiments are being carried out with *P. globosa* and *T. oceanica*.

Our results indicate that marine algae are important for the global cycling of Se, especially in low phosphate regimes such as oligotrophic waters and late stage phytoplankton blooms.