Diel cycles of arsenic (As) speciation and partitioning: High resolution monitoring in a coastal system

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Abstract

Biogeochemical controls on arsenic (As) cycles/speciation have been studied for many years, yet little is known about As dynamics in coastal waters at daily timescales. Dissolved As species and particulate total As along with a set of bio-physicochemical parameters were observed hourly during two complete tidal cycles in the shallow Arcachon Bay. Both total dissolved As (AsTD) and As(III) were measured by HG-AAS analysis, while particulate As was measured by ICP-MS after total digestion. During the 31 h high-resolution monitoring, strong cyclic variations in major variables and As speciation in the water column occurred and were explained by (i) the strong influence of the tidal cycle (water masses) on the majority of physico-chemical parameters and (ii) the importance of biochemical processes for As concentrations and speciation. Daily cycles of phytoplanktonic pigments (associated with effective insolation, i.e. turbidity corrected light abundance) served as a proxy of primary production/degradation. Speciation of dissolved As followed these cycles showing increasing As(III) percentages (up to 40% of AsTD) in the water column during intense primary production, supporting the uptake of As(V) (arsenate instead of phosphate) by phytoplankton and excretion of As(III) due to reducing detoxification mechanisms. A nighttime peak in As(III) percentages coinciding with the highest phaeo/Chla pigment ratios was attributed to plankton degradation reflecting either microbial reduction processes or release of As(III) during plankton cell lysis. This biological uptake-release cycle implies a turnover of up to _˜ 40% of the AsTD, within few hours. These findings suggest that short-lived (hours to days) As radionuclides accidentally released in coastal waters may rapidly enter the first level of the marine food chain, implying exposure of internal parts of the cell to radiation, potential subsequent release as more soluble As(III) or decay inside the cells forming new stable elements (e.g. Selenium) with different effects and fate.

Keywords: arsenic, speciation, diel cycle, seawater

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