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## Arsenic and phosphorus biogeochemistry in the ocean: Arsenic species as proxies for P-limitation

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Limnol. Oceanogr., 58(2), 2013, 729-740 | DOI: 10.4319/lo.2013.58.2.0729

**ABSTRACT:** Arsenic and phosphorus are biochemically very similar, and hence arsenate ( $As^{3AsPUs}$ ) is toxic by interfering with the energy metabolism, in particular during P limitation. However, many phytoplankton detoxify As by reducing arsenate to arsenite ( $As^{3AsPUs}$ ), and/or methylating it to mono and dimethyl As. Such As detoxification becomes operative in oligotrophic waters when phosphate concentrations are below those for As; therefore, we evaluated the potential use of these detoxification products as indicators of P limitation by measuring As speciation during the US GEOTRACES North Atlantic transect. The distribution of  $As^{3AsPUs}$  concentrations in surface waters is similar to that of N : P ratios and alkaline phosphatase activity (APA), two conventional proxies for P-limitation.  $As^{3AsPUs}$  concentrations have a very similar relationship to phosphate as APA to phosphate, and therefore indicate the potential of  $As^{3AsPUs}$  as proxy for P-limitation. From the relationship to phosphate we derived threshold values of  $As^{3AsPUs}$  concentration to indicate moderate and extreme P-limitation. We then applied these threshold values to assess P-limitation with high horizontal resolution in the North Atlantic, improving on the contradictory assessment using the conventional proxies. Our new evaluation is consistent with the general concept that the North Atlantic is moderately to extremely limited in phosphate.

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