Nanoscale colloidal iron-binding organic matter in marine waters

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The specific binding of iron to different types of nanoscale (0.5-100 nm) marine colloids was investigated, in natural seawater samples, plankton exudates and synthetic seawater with organic model compounds. Seawater samples, ranging in salinity from 18 to 32, were taken from the Mississippi River outflow region in the northern Gulf of Mexico. The continuous colloidal size spectra of iron, CDOM, and humic-type and protein-type fluorescent organic matter were determined using field-flow fractionation (FFF) coupled on-line to detectors including UV-absorbance, fluorescence and ICP-MS. Samples were also spiked with enriched ^{59}Fe, followed by FFF analysis, filtration (with membrane cutoff of 0.02 and 0.45 μm, 3, 10, 50 and 100 kDa), gamma counting and 3D excitation emission matrix spectrofluorometry, to investigate the influence of different types of colloids on the iron solubility. The results showed that iron binds strongly to fulvic acid, protein and protein-like compounds in plankton exudates, while the affinity for acidic polysaccharide was lower. In the Mississippi River plume samples, both naturally occurring iron and the spiked ^{59}Fe were associated with small (0.5-4 nm) humic-type fluorescent organic matter. In samples taken at high salinity and during periods of higher biological productivity, the colloidal iron size spectra of spiked ^{59}Fe was shifted to larger sizes, suggesting that formation of colloidal iron-hydroxide had occurred. We hypothesize that terrestrial fulvic acid dominate the binding of iron in the colloidal size range in coastal seawater, but that biopolymers produced *in situ* can be important for binding iron in oceanic surface waters.

The microbial transformation of arsenic in extreme environments

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Despite its relatively low crustal abundance, arsenic can reach significant levels and have a robust biogeochemical cycle in some environments, such as Mono Lake California [1]. Oxidation/reduction reactions in particular, are central as they are linked to organic matter mineralization and carbon fixation. Arsenate can serve as an electron acceptor in anaerobic respiration while arsenite can serve as an electron donor in respiration and even photoautotrophy [2]. The ability to metabolize arsenic is distributed throughout the Bacteria and Archaea domains and different biochemical pathways are involved [3]. The analyses of available annotated genomes of both arsenite oxidizing and arsenate reducing bacteria show a striking conformity in the catalytic and Fe-S cluster containing subunits of both arsenite oxidase and arsenate reductase but a great diversity in additional subunits and regulatory elements. Studies of the physiology, biochemistry, genomes, and proteomes of bacteria isolated from Mono Lake have provided insight into arsenic metabolism. For example, dissimilatory arsenate reductase has been shown to be a reversible enzyme and function as an arsenite oxidase in the chemolithoautotroph *Alkalilimnicola ehrlichii* [4] and may also be the case for the photoautotroph PHS-1 [2]. This versatility further underscores the ubiquity and antiquity of microbial arsenic metabolism.

[1] Oremland *et al*. (2004) *FEMS Microbiol Ecol* **48**, 15–27. [2] Kulp *et al*. (2008) *Science* **321**, 967–970. [3] Stolz *et al*. (2006) *Ann Revs Microbiol* **60**, 107–130. [4] Richey *et al*. (2009) *Biochem Biophy Res Comm* **382**, 298-302.