Microbial processes that impact iodine speciation at environmentally relevant concentrations

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^{129}I poses a potential threat to human health due to its propensity to accumulate in the thyroid gland and its long half-life (16M years). Produced primarily via fission processes in nuclear reactors, elevated levels of ^{129}I are often found surrounding nuclear facilities, and it was released into the atmosphere and subsequently deposited following the Cherbonyl and Fukushima accidents. Based on thermo-dynamic principles, ^{129}I should exist primarily as iodide (I^-) in most terrestrial environments, however using analytical methods designed to detect iodine at environmentally relevant concentrations our team has found that organo-iodine and iodate typically comprise >50% of the ^{129}I species in soils, sediments and groundwater [1, 2, 3]. Factors, other than pH and Eh, must therefore be important regulators of ^{129}I speciation in the environment.

To evaluate the environmental relevance of these and other microbial processes on iodide speciation, we examined fungal and bacterial-mediated iodide oxidation at micromolar concentrations (i.e. 10-100 μM). Thus far, we have not found that microbial enzymes play a prominent role in iodide oxidation at these concentrations. Rather, we have identified several indirect mechanisms whereby micoorganisms facilitate iodide oxidation including 1) lowering the pH of the local microniche, 2) formation of highly oxidizing peroxy carboxylic acids and 3) generation of extracellular superoxide [4, 5]. Biogenic manganese oxides, although previously implicated in iodide oxidation, did not support significant levels of iodide oxidation at pH values >5 in the laboratory. Overall, the results lead us to hypothesize that strongly oxidizing byproducts of general metabolic and respiratory processes, secreted by a variety of microorganisms, are more likely agents of I^- oxidation in terrestrial environments than is direct enzymatic catalysis.

[1] Zhang (2010), *Environ. Sci. Technol.* 44, 9042-9048. [2] Xu (2015), *J. Environ. Radioact.* 139:43-55. [3] Xu (2015), *J. Environ. Radioact.* 153, 156-166. [4] Li (2014), *Appl. Environ. Microbiol.* 80, 2693-2699. [5] Li (2012), *Environ. Sci. Technol.* 46, 4837–4844.