Potential for Immobilization of ^{99}Tc at the Hanford Site by Stimulation of Subsurface Microbiota

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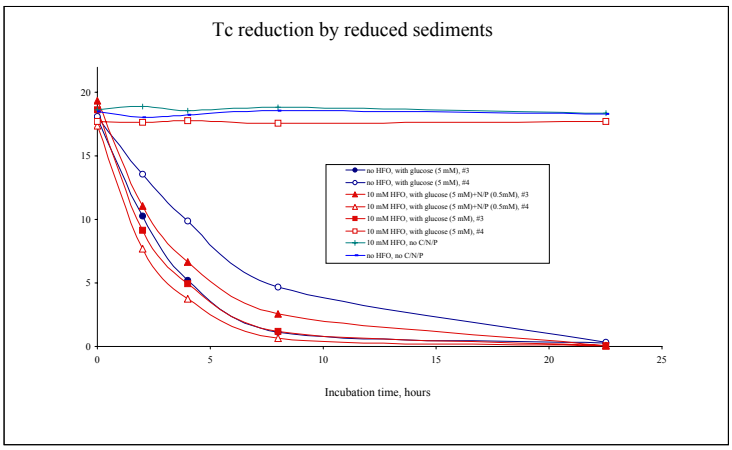
The objective of this project is to evaluate the applicability of direct and/or Fe(II)-facilitated ^{99}Tc reduction by microbes to the problem of ^{99}Tc groundwater contamination at the Hanford site. Our initial research focused on laboratory studies with field samples from the Hanford site to establish the existence and metabolic requirements of microorganisms native to Hanford subsurface sediments that are capable of directly or indirectly mediating $Tc(VII)O_4^-$ reduction. We have successfully biostimulated Hanford formation sediments, and have demonstrated the bioreduction of native and exogenous Fe(III). These bioreduced sediments also effectively remove $^{99}TcO_4^-$ from solution, presumably via biogenic Fe(II)-facilitated reduction. Subsurface samples from below the water table beneath the former North Process Pond in the 300 Area at Hanford were incubated with a wide range of electron donors with or without nutrient amendments. A key result from these incubations is that initial biostimulation in the laboratory required ~120 days to achieve significant levels of Fe(III) reduction. However, once biostimulation was achieved (marked by reduction of oxidized iron in the incubation tubes), $Tc(VII)O_4^-$ was readily reduced. Lactate, glucose, and glucose with N+P promoted the greatest Fe(III) and $Tc(VII)O_4^-$ reduction. Furthermore, $Tc(VII)O_4^-$ added to incubation tubes after bioreduction was reduced in a matter of hours (see figure). A number of anaerobic bacteria have been isolated from the 300 Area sediments that can grow with lactate with fumarate as the electron acceptor or with glucose with Fe(III) as the electron acceptor. These cultures are currently being characterized with regards to their phylogeny and ability to reduce $Tc(VII)O_4^-$.



Because our laboratory-scale experiments show response to biostimulation, and we now know that the kinetics of the initial stimulation process are relatively slow, we are evaluating the use of repeated single-well push-pull tests for determining the viability of in situ reduction of ^{99}Tc by native microorganisms (in collaboration with Jack Istok, Oregon State University). Our long-term goal is a field-scale ^{99}Tc bioreduction experiment to verify, under large-scale field conditions, laboratory results indicating that in situ bioremediation of ^{99}Tc may be feasible and ultimately lead to a relatively low-cost means of decreasing risk from ^{99}Tc at the Hanford site.