Characterization of the Fate and Biotransformation of Fluorochemicals in AFFF-Contaminated Groundwater at Fire/Crash Testing Military Sites (ER-2128)

Objective

Aqueous film forming foams (AFFF) are complex mixtures of fluorocarbon surfactants that have been an essential tool used by the Department of Defense (DoD) and others since the 1960s to extinguish fires at airports and training sites and on ships. There are hundreds of fire/crash training areas at military sites where training fires were routinely started by igniting waste hydrocarbons or halogenated solvents and then AFFF was applied, thus creating mixed-waste sites. Consequently, repeated applications of AFFF at military fire-training sites have resulted in hundreds of fluorochemical-contaminated groundwater, sediment, and soil sites. Little is known about the chemistry of AFFF except that it is a complex mixture of fluorochemicals and surfactants that results in the generation of persistent fluorochemicals from partially fluorinated precursors.

The objective of this project is to fully delineate the fluorochemicals that persist in AFFF-contaminated groundwater, sediment, and soil and evaluate their impact on priority pollutant transport and bioremediation.

Technical Approach

Fast atom bombardment mass spectrometry (FAB/MS) will be applied to characterize the fluorochemical and hydrocarbon chemical classes and their respective fluorinated chain-length distributions in authentic AFFF formulations. Further, for quantification and to distinguish branched from linear-chain isomers of each homolog, liquid chromatography-tandem mass spectrometry (LC-MS/MS) will be used. These methods will enable the accurate relation of the fluorochemicals detected in stockpiles and in field samples to original AFFF formulations sold on Mil Spec to the military. In order to quantify total concentrations of fluorinated compounds that serve as precursors for perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), and related compounds, researchers will develop a method that exposes samples to hydroxyl radicals as unselective oxidants prior to analysis. These methods will be applied to evaluate the biotransformation of AFFF and its breakdown products in microcosms with pristine and contaminated sediments and groundwater.

Benefits

By developing a better understanding of the fluorochemical contaminants in AFFF and their fate and transport in the subsurface, DoD and the Department of Energy (DOE) will be better able to apply remediation approaches that decrease the time and cost required to monitor and treat contaminated soil and groundwater systems. (Anticipated Project Completion - 2014)