In-Well Tests to Determine Indigenous Naphthalene Biodegradation under Sulfate Reducing and Methanogenic Conditions

Carol Lee Dona, Thomas Georgian, and Charles Coyle (US Army Corps of Engineers, Omaha, Nebraska, USA)
Aaron Peacock and Greg Davis (Microbial Insights Inc., Rockford, Tennessee, USA)
Justin Barker (Shaw Environmental, Lenexa, Kansas, USA)
Kerry Sublette (The University of Tulsa, Tulsa, Oklahoma, USA)
John Wilson (Environmental Protection Agency, Ada, Oklahoma)
Patricia Bowlin (Environmental Protection Agency, Region 9, San Francisco, CA)

The McCormick & Baxter Superfund Site, is a former creosoting manufacturing site located in Stockton, CA, that operated from 1942 until 1991. Poly aromatic hydrocarbons (PAHs) characteristic of creosote contamination are present in the groundwater, as well as other petroleum hydrocarbons. Historical data show that naphthalene, which is widespread at the site, has migrated in the groundwater significantly less than expected hydrogeologically, suggesting that degradation of naphthalene is occurring. The data from this study, along with data from additional biological studies, will be used in a groundwater model to evaluate the feasibility of using monitored natural attenuation as a stand-alone alternative and in combination with other technologies for the remediating the groundwater.

The purpose of this study was to determine the ability of the indigenous microbial community to degrade naphthalene under the generally sulfate reducing and methanogenic conditions in the groundwater. Field tests were conducted using Bio-trap sampling devices enriched with $^{13}$C naphthalene. Twenty two in situ tests were conducted in nineteen different locations, which generally represented either sulfate reducing or methanogenic conditions from source or fringe plume areas across the five different aquifer zones where PAH contamination is present. After field incubation the Bio-traps were analyzed for $^{13}$Carbon in the microbial lipid biomass, residual $^{13}$Carbon naphthalene in the trap, the $^{13}$Carbon in the carbon dioxide captured by trap beads, and $^{13}$Carbon in the methane captured by the trap. The groundwater in equilibrium with the Bio-trap was also analyzed for anions and non-$^{13}$C -enriched dissolved gases (methane and carbon dioxide).

Of the nineteen locations tested all locations had measurable enriched $^{13}$Carbon in the microbial lipid biomass. Measurable enriched $^{13}$C CO$_2$ was detected at eight locations across the site. There was no $^{13}$Carbon above background measured in methane recovered from the traps at any location. The ability of the microbial community to degrade naphthalene appears to be widespread across the site, with the type of terminal electron acceptor process (TEAP) and physical location (aquifer zone) both influencing the microbial community biomass, composition, physiological status and the resulting naphthalene degradation.
Corresponding/presenting author information:
Carol Lee Dona
US Army Corps of Engineers Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
Omaha, NE 68101
(402) 697-2582 (phone)
(402) 697-2613 (fax)
Carol.l.dona@usace.army.mil

Coauthor list and information
Thomas Georgian
US Army Corps of Engineers Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
Omaha, NE 68101
(402) 697-2567 (phone)
(402) 697-2613 (fax)
Thomas.Georgian@usace.army.mil

Charles Coyle
US Army Corps of Engineers Environmental and Munitions Center of Expertise
1616 Capitol Ave, Suite 9200
Omaha, NE 68101
(402) 697-2578 (phone)
(402) 697-2613 (fax)
Charles.G.Coyle@usace.army.mil

Aaron Peacock
Haley and Aldrich
103 Newhaven Rd
Oak Ridge, Tenn. 37830
913 787 4172 (phone)
865 300-8053 (fax)
APeacock@haleyaldrich.com

Greg Davis
Microbial Insights
2340 Stock Creek Blvd.
Rockford, TN 32853-3044
865 573-8188, X 101 (phone)
865 300-8053 (fax)
gdavis@microbe.com

John Wilson
EPA Kerr Research Center
919 Kerr Research Drive
Ada, OK 74820
Phone (580) 436-8534  
Fax (580) 436-8703  
wilson.johnt@epa.gov

Kerry Sublette  
University of Tulsa  
Dept. of Chemical Engineering  
600 S. College Ave.  
Tulsa, OK 74104  
Phone (918) 631-3085  
Fax (918) 631-3268  
kerry-sublette@utulsa.edu

Patricia Bowlin  
US EPA Region 9  
75 Hawthorne St.  
San Francisco, CA 94105  
415 972-3177 (phone)  
415/947-3526 (fax)  
Bowlin.Patricia@epamail.epa.gov

Sessions to include in: 1.4 or 4.6.