Measurement & Monitoring:
26th Quarterly Literature Update

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1,4-Dioxane: The Impact of Analytical Method -- A Case Study
Linton, P.J. (Blasland, Bouck, and Lee, Inc., Tampa, FL); T. Armstrong (Lockheed Martin, Bethesda, MD); J. Alonso and B. Foster (Blasland, Bouck, and Lee, Inc.).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Commercial laboratories commonly analyze for 1,4-dioxane (CAS 123-91-1) in groundwater by either EPA Method 8260 or 8270, though 1,4-dioxane is not listed for the latter method. Method 8260 generally does not achieve reporting limits that meet regulatory concentrations. Determination of 1,4-dioxane in water at low detection levels also can be accomplished using a modified approach to Method 8270 with isotope dilution. Because of time and sample volume concerns, many laboratories have begun analyzing for 1,4-dioxane using a modified Method 8260 with specific ion monitoring (SIM) GC-MS to improve the detection limits. During recent characterization sampling at a central Florida site in groundwater affected by chlorinated volatile organic compounds and 1,4-dioxane, split samples of groundwater were collected and analyzed by both Method 8270 and 8260 SIM. The difference in reported concentrations of 1,4-dioxane by the two methods was significant, sometimes by orders of magnitude. A study was initiated to evaluate the effect of the different analytical methods on reported concentrations. This paper presents an evaluation of the comparison of Method 8260 SIM, Method 8270, and Method 8270 with isotope dilution using native samples, multiple-level spike addition, and multiple-concentration laboratory control sample analysis to evaluate the overall accuracy and precision of the three methods. Potential interference by other compounds that might affect the reported concentration by Method 8260 SIM is also evaluated.

A 3D Resistivity Tomography Study of a LNAPL Plume Near a Gas Station at Brugelette (Belgium)
Kaufmann, Olivier and John Deceuster, Faculty of Engineering Mons, Belgium.
Journal of Environmental & Engineering Geophysics, Vol 12 No 2, p 207-219, 2007

A field experiment was conducted over a site contaminated with light nonaqueous-phase liquid (LNAPL) from a leaking gasoline tank. In an area where a dolomitic bedrock is overlain by 5 to 9 m of clayey sands, 10 boreholes were drilled and four cone penetration tests were conducted to delineate the plume and measure piezometric heads and depths to bedrock. Soil and water samples were collected and analyzed. Although sampling indicates the presence of hydrocarbons in some boreholes, the plume is poorly outlined due to the limited number of drillings. A laboratory study was undertaken to predict the response of hydrocarbon-contaminated areas in this specific context. The study results indicate that an increase in resistivities of about 40% should be found in highly polluted areas. To assess the contribution of geo-electrical investigations in delineating hydrocarbon-contaminated areas, a 3-D cross-diagonal resistivity survey was performed using a roll-along technique. The electrical dataset was inverted within Res3DInv to build a resistivity-depth model of the ground. High resistivities suggest a bedrock geometry, which is consistent with the drilling results, but a detailed analysis reveals that rockhead resistivities tend to be significantly higher in the areas where gas was detected in sample analyses than in uncontaminated areas. Resistivities plotted on the water table showed a zone of higher resistivities near the tank than in uncontaminated zones. This increase in resistivities is interpreted as a possible effect of the fresh and mobile LNAPL plume. Combining boreholes and geophysical investigations has the potential to lead to a better delineation of the spill extent. [Note: The authors state incorrectly that Ogilvy et al. 2002 used only the pole-pole array; in actuality, a pole-dipole array was used for the 3D ERT study. A correction was published 12(4):353(2007).]

Acid Mine Drainage and Assessment of Recent Remediation Efforts at the Blue Ledge Mine, Siskiyou County, California

Elliott, W.S. Jr, J.A. Johnson, and M.A. Wikstrom (Southern Oregon Univ., Ashland); P.T. Jones (North Medford High School, Medford, OR).

Geological Society of America Abstracts with Programs, Vol 39 No 6, p 404, Paper 145-1, 2007

The Blue Ledge Mine in Siskiyou County, CA, exploited a polymetallic massive sulfide deposit from 1906 to 1919, producing over 60,000 tons of waste rock, most of which remains on a 20- to 40-degree slope at the site. Standing pools of water within abandoned adits of the mine have pH values ranging from 1.2 to 3.5, total dissolved solids that vary seasonally from 300 to over 2,000 ppm, and temperatures between 10 and 20 degrees C. Geochemical data collected bi-weekly from effluent in the adits and the surface waters around the mine have established a seasonal trend in the metal concentrations, pH, and total dissolved solids. During the dry summer months, the acidity increases, with the lowest pH measured at 1.2, and the concentrations of As, Cd, Cu, Fe, Pb, and Zn increase in standing pools of water within the adits. During the summer, there is no water movement in the run-off channels from the mine except during rare summer rain events. Longer-duration precipitation events beginning in October flush concentrated acid mine drainage (AMD) from the adits, along with remobilizing precipitated sulfates from the waste rock piles into runoff channels. These runoff channels empty into nearby Joe Creek, lowering the pH and inducing toxic metal loading in the stream. The high gradient of Joe Creek rapidly oxygenates the water, resulting in the precipitation of numerous iron oxides and hydroxides in the streambed. In September 2006, the U.S. Forest Service and U.S. EPA undertook remedial activities at the site. The waste rock piles were terraced and material moved to create a settling pond and direct AMD into a runoff channel. Rip-rap in the runoff channel consists of marble boulders, which became coated with iron precipitates in less than three weeks. Thus far, monitoring of water chemistry of AMD from the Blue Ledge Mine indicates minimal impact of the remedial effort, possibly due to the overwhelming release of AMD from the disturbance of the waste rock piles during site activities and/or the large size of the rip-rap. Monitoring of the geochemistry of AMD from this site will be used to develop additional remediation designs.

Airborne Visible / Infrared Imaging Spectrometer (AVIS): Design, Characterization and Calibration

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Sensors, Vol 7 No 9, p 1934-1953, 2007

AVIS, the Airborne Visible/Infrared-imaging Spectrometer, is a hyperspectral imager designed for environmental monitoring purposes. Constructed entirely from commercially available components, the sensor was deployed successfully in experiments between 1999 and 2007. This paper describes the design of the instrument and presents the results of laboratory characterization and calibration of the currently operating second-generation system, AVIS-2. The authors also describe the processing of the data and present examples of remote sensing reflectance data.

http://www.mdpi.net/sensors/list07.htm

Analysis Method for Congener Isomer by Series of Polar and Non-polar Column GC Combination

Jung, J.-H. and S.-W. Eom (Seoul Metropolitan Govt. Research Inst. of Public Health and Environment, Korea); S.-G. Ahn (Univ. of Seoul, Korea).

The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

In the analysis of dioxins, all 17 of the toxic isomers cannot be separated with a single column. Seven dioxins and 10 furans are separated and quantified with a polar and non-polar column one by one. Analysis can be refined by pre-treating samples with more than 2 columns, which requires more time and increases costs due to the need to readjust sensitivity and calibration curves. The authors have worked out a method that can separate 2,3,7,8-TCDD with one-time analysis quickly by combining 2 different columns. A polar SP-2331 column and a non-polar DB-5MS column were connected in line using 2 GC units and maintaining the optimum temperature for each polar and non-polar column at 350 and 275 degrees C, respectively. With one shot of sample, the first GC with the relatively higher temperature separated substances from low chloride to high chloride using 60m a non-polar DB-5MS column, and then the second GC at a relatively lower temperature separated the substances using a polar SP-2331 column (which had various lengths of 1m, 2m, 3m, 4m, 5m, 6m and 10m) to see the change of resolution degree. The resolution degree of specific isomer from 2,3,7,8-TCDD could be improved by changing the elution characteristics.

Analysis of Sulfur in the Copper Basin and Muddy River Sites Using Portable XRF Instrumentation

Berger, M. (Simmons College, Boston, MA); L. Stupi and R. Schleicher (Thermo Fisher Scientific, Billerica, MA).

The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Both Copper Basin, which is located near the junction of Tennessee, Georgia, and North Carolina, and the Muddy River in Boston, Massachusetts, present elevated levels of sulfur (S) in soils and sediments. The Copper Basin was once an active mining site and the elevated sulfur presence there is a result of pollution from mining activities. One of the first steps is the identification and removal of S-rich soils (greater than 2%), which are thought to have the greatest potential for acid mine drainage. The selection of a remediation strategy that minimizes volatile emissions of sulfur during sediment dredging operations could be aided by S analysis of Muddy River sediments. S previously has been considered too light an element to be detected with portable X-ray fluorescence (XRF); however, recent technological advances now support the potential to detect and sometimes quantify S. The detection limit of S previously was established at approximately 1%, but new He-purge capabilities are pushing that number down to one-third of that value. Data are presented from investigations of Copper Basin soils and Muddy River sediments to demonstrate the capabilities and effectiveness of the analyzer for site characterization and remediation activities. Analytical results obtained with XRF are compared to traditional S analytical methods.

Application of Comprehensive Two-Dimensional Gas Chromatography for the Assessment of Oil Contaminated Soils

Van De Weghe, H., G. Vanermen, J. Gemoets, R. Lookman, and D. Bertels, VITO, Mol, Belgium.

Journal of Chromatography A, Vol 1137 No 1, p 91-100, 22 Dec 2006

An alternative method for characterizing pollutants in oil-contaminated soil was developed using comprehensive 2-D gas chromatography (GCxGC) with FID. Sample preparation was limited to pressurized liquid extraction (PLE), and the analysis was carried out on a commercially available instrument with a conventional column combination (RTX-1/BPX50) and with standard chromatographic software. Compared to the total petroleum hydrocarbon (TPH) method, the group types in the GCxGC analysis are better defined chemically and more specific information is obtained, especially for the aromatic hydrocarbon fraction. Preliminary results indicate that higher recoveries and lower RSDs are obtained with GCxGC, probably because of the less complex sample preparation. A data processing method was developed to generate TPH results from GCxGC data; the volatility distribution profiles compared well with conventional TPH data. The possibility of extracting physicochemical properties directly from the GCxGC chromatogram was briefly explored, but software limitations hindered this potential application.

Application of Luminescent Biosensors for Monitoring the Degradation and Toxicity of BTEX Compounds in Soils

Dawson, J.J., C.O. Iroegbu, H. Maciel, and G.I. Paton.

Journal of Applied Microbiology, Vol 104 No 1, p 141-151, Jan 2008

In an assessment of the changes in acute toxicity and biodegradation of BTEX compounds in soil over time and comparison of the performances of biological and chemical techniques, biological methods (lux-based bacterial biosensors, basal respiration and dehydrogenase activity) were related to changes in the concentration of the target compounds. An initial increase in toxicity determined by the constitutively expressed biosensor was observed, followed by a continual reduction as degradation proceeded. The biosensor with the BTEX-specific promoter was most induced when BTEX concentrations were highest. The treatment with nutrient amendment had a significant increase in microbial activity, while the sterile control produced the lowest level of degradation. The researchers found that luminescent biosensors were able to monitor changes in contaminant toxicity and bioavailability in aqueous extracts from BTEX-impacted soils as degradation proceeded. The integration of biological tests with chemical analysis enabled a fuller understanding of the biodegradation processes occurring at their relative rates. While chemical analysis showed biodegradation of parent BTEX compounds in biologically active soils, the biosensor assays reported on changes in bioavailability and potentially toxic intermediate fractions as they estimated the integrative effect of contaminants.

Assessment of Open Pit Coal Mining Impacts Using Remote Sensing: A Case Study from Turkey

Toren, T. (General Directorate of Turkish Coal Enterprises, Ankara, Turkey); E. Unal (Middle Eos! Technical University, Ankara, Turkey).
IMCET 2001: 17th International Mining Congress and Exhibition of Turkey, p 461-466, 2001

Remote sensing technology affords a viable means of analyzing the changing conditions at mine sites. In this study, multi-temporal Landsat thematic mapper (TM) data sets from the Soma coal basin were subjected to digital image processing techniques to assist in identifying and monitoring the environmental impacts. The application of digital image processing proved to be an effective means of analyzing the multitemporal data set.
http://www.maden.org.tr/resimler/ekler/0b8fe090143d577_ek.pdf

Assessment of Risk of the Release of Combustible Vapors during Solidification/Stabilization Treatment of Highly Contaminated Sediment

Balba, T., S. Dore, D. Pope, J. Smith, and A. Weston, Conestoga-Rovers & Associates, Niagara Falls, NY.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Solidification/stabilization (S/S) is often implemented to decrease the toxicity of sediments contaminated with metals and PCBs and allow them to be left in place or disposed of safely. For sediments that are highly contaminated with VOCs, however, the physical act of mixing or the reaction between the sediments and the solidification agent has the potential to release toxic material into the air. A treatability study was performed to assess this risk for a sediment contaminated with metals and volatile hydrocarbons and to determine whether S/S was a viable option for sediment with the potential to release combustible vapors. The sediment contained very high levels of hexane and heptane. There was a concern that treatment could vaporize combustible levels of the hydrocarbons from the sediment. Solidification tests were set up using different concentrations of solidification agents. The temperature of the sample and the air above the sample were monitored during the mixing tests to determine whether solidification of the sediment would result in the production of potentially combustible heat or vapors. Calcium oxide (quicklime) was the preferred solidification agent, but it was expected to produce heat on contact with the wet sediment and was therefore associated with the highest risk of combustion. Analysis of the vapor above the sample showed that the heat generated by the reaction of typical treatment dose did not appear to increase volatilization of hydrocarbons from the sediment; however, significant volatilization occurred if a larger amount of quicklime was mixed with the sediment. This bench-scale treatability study allowed the optimum solidification and dose to be selected and the potential for the release of combustible vapors to be assessed in a safe, timely, and cost-effective manner.

Assessment of the Fate of Organic Groundwater Contaminants Using Their Isotopic Signatures
Zwank, Luc, Ph.D. dissertation, Swiss Federal Institute of Technology Zurich, Diss. Eth. No. 15378, 161 pp, 2004

The dissertation investigated both analytical methods for determining concentrations of gasoline oxygenates, major degradation products of methyl tert-butyl ether (MTBE) and BTEX and the use of isotopic analysis to evaluate the source of chlorinated hydrocarbons and their degradation products as well as MTBE and its degradation products. The author found that direct aqueous injection (DAI) GC/MS was a good method for the routine determination of gasoline spill components. Purge and trap (P&T) was found to be the most efficient preconcentration technique for continuous-flow isotope ratio determinations. Using these tools an examination of the isotopic fractionation factors for abiotic reactions versus biotic was conducted for tetrachloromethane, perchloroethene (PCE), trichloroethene (TCE), MTBE, and tert butyl alcohol (TBA). The results show significant isotopic enrichment of tetrachloromethane in the presence of iron containing minerals indicating abiotic reduction is occurring. In addition, the author also determined that there were significantly different enrichment ratios for the abiotic versus biotic degradation of PCE, but this was not true for TCE; however, the stable hydrogen isotopic signatures of TCE and cis-1,2-dichloroethene (cis-DCE) can be used to infer the source of these compounds because manufactured chlorinated ethenes are usually enriched in 2H (> +500‰ for TCE and, > +300‰ for cis-DCE), while the compounds originating from the degradation of higher chlorinated ethenes are depleted by 50‰ for TCE and 100‰ for cis-DCE. Dissertation at http://e-collection.ethbib.ethz.ch/show?type=diss&nr=15378&part=fulltext

Biochemical Markers for Assessing Aquatic Contamination
Havelkova, M., T. Randak, V. Zlabek, J. Krijt, H. Kroupova, J. Pulkrabova, and Z. Svobodova. Sensors, Vol 7 No 11, p 2599-2611, 2007

Enzymes of the first phase of xenobiotic transformation -- ethoxyresorufin-O-deethylase (EROD) and cytochrome P450 -- were used to determine the quantities of persistent organic pollutants (PCBs, HCB, HCH, OCS, DDT) in fish muscle. Eight rivers were monitored--Orlice, Chrudimka, Cidlina, Jizera, Vltava, Ohre and Bilina; the River Blanice was a control. The chub (Leuciscus cephalus L.) was selected as the indicator species. No significant differences were found in cytochrome P450 content between the locations monitored. The highest concentration of cytochrome P450 in fish liver was in the Vltava (0.241 nmol/mg protein), and the lowest was in the Orlice (0.120 nmol/mg protein). Analysis of EROD activity showed a significant difference between the Blanice and the Vltava ($P< 0.05$), and also between the Orlice and the Vltava ($P< 0.01$), the Orlice and the Bilina ($P< 0.01$), and the Orlice and the Ohre ($P< 0.05$). The highest EROD activity in fish liver was in the Vltava (576.4 pmol/min/mg protein), and the lowest was in the Orlice (63.05 pmol/min/mg protein). In individual locations, results of chemical monitoring, and values of biochemical markers were compared. A significant

correlation ($P < 0.05$) was found between biochemical markers and OCS and PCB. Among the tributaries studied, the Vltava and the Bilina contributed the most contamination to the Elbe, although these tributaries should not be considered the main sources of industrial contamination when the most important contamination sources lie along the river Elbe itself.
http://www.mdpi.net/sensors/list07.htm

Biologically enhanced mass transfer of tetrachloroethene from DNAPL in source zones: Experimental evaluation and influence of pool morphology
Glover, Kent C., Junko Munakata-Marr, and Tissa H.Illangasekare,
Environmental Science and Technology v 41 n 4, p 1384-1389, 15 Feb 2007

The authors constructed a flow through cell to investigate whether DNAPL architecture would make a difference in the effects microbial activity would have on the DNAPL mass. They found for average pool saturations of under 0.55, biodegradation enhanced mass transfer by factors of 4 to13. However, when the average saturation was increased to 0.74, the mass transfer rate dropped to a factor of less than 1.5. Pools that had an observable transition zone experienced significantly greater mass transfer than more compact pools. The authors also found that advective flow through multiphase transition zones enhanced dissolution and biological activity. The results suggest that bioremediation may be an effective remediation strategy for depletion of source zones with the proper architecture.

Biomonitoring of Environmental Pollution Using Dielectric Properties of Tree Leaves
Saltas, V., V. D. Triantis, T. Manios and F. Vallianatos
Environmental Monitoring and Assessment, Vol 133 Nos 1-3, p 69-78, 2007

The authors investigated whether there would be a difference in the dielectric relaxation properties of tree leaves taken from a polluted urban site and those coming from a relatively clean site. They found that the leaves exhibited different features in the recorded spectra and concluded that dielectric relation measurements are a promising biomontioring technique for heavy metals pollution.

Biosensors and Bio-Bar Code Assays Based on Biofunctionalized Magnetic Microbeads
Jaffrezic-Renault, N., C. Martelet, Y. Chevolot, and J.-P. Cloarec.
Sensors, Vol 7 No 4, p 589-614, 2007

Affinity biosensors for immunodetection and genodetection can be presented through electrochemical, piezoelectric, or magnetic transducing systems. Enzymatic biosensors are based most frequently on amperometric, potentiometric or conductimetric biofunctionalization through magnetic microbeads of a transducer. The bio-barcode assays rely on a sandwich structure based on specific biological interaction of a magnetic microbead and a nanoparticle with a defined biological molecule. The magnetic particle allows the separation of the reacted target molecules from unreacted ones. The nanoparticles aim at the amplification and the detection of the target molecule. The bio-barcode assays allow detection at very low concentrations of biological molecules, similar to PCR sensitivity. Future work likely will focus on optimizing biological molecule immobilization to reduce cross-reactivity and to lower non-specific adsorption.
http://www.mdpi.net/sensors/list07.htm

The Case on the Source Identification of Spilled Oil with Mixed Free Product in Seoul
Eom, S.W., I.-S. Bae, and J.-S. Lee, Seoul Metropolitan Govern Research Institute of Public, Health and Environment, Seoul, Korea.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Analyses of free product and oil compounds in soil and groundwater were undertaken to identify the contaminant source near a subway station adjacent to the Army garrison in Seoul, Republic of Korea. Samples were analyzed for boiling point range, TPH fingerprinting, pristine/phytane ratio, alkylbenzene pattern, polycyclic hydrocarbons, PIANO (GC to determine the amount of paraffin, isoparaffins, aromatics, naphthalene, and olefins present), elements (C, N, H), sulfur, and stable isotopes (C-13/C-12). Determining the ratio of pristine/phytane enabled the investigators to distinguish between kerosene and JP-8 samples, a process that was impossible using only the GC/FID pattern. The alkyl benzene pattern was very effective in distinguishing between JP-8 and kerosene, and the presence of a large amount of other fuel type posed no significant interference. 2,4-Dimethyl-6-tert-butyl phenol, an antioxidant used only for JP-8, was detected in the free product samples. The concentration of sulfur in kerosene fuel is much lower than in JP-8, and the total content of sulfur in environmental samples presented another method to differentiate between spills of kerosene and JP-8.

Case Study: Petroleum-Contaminated Soil Stockpile Multi-Increment Sampling, Prince of Wales Island, Southern Southeast Alaska
Alaska Department of Environmental Conservation, 9 pp, Aug 2007

To test the protocols in the Alaska DEC's draft Multi-Increment Sampling Guidance, a small soil stockpile in a rock quarry on Prince of Wales Island near Craig was sampled. During the 2006 excavation and removal of an underground heating oil tank, discrete samples were collected that documented diesel range organics (DRO) between 300 to 900 mg/kg. Stockpile tilling and fertilizing were conducted by the responsible party several times after the soil was moved from its original location in May 2006. DEC personnel sampled the stockpile on May 24-25, 2007. Multi-increment bulk samples were collected from 90 different locations in the 12-15 cubic yard stockpile. Sub-samples were sieved to 2 mm and placed in sample jars for laboratory analysis. Fundamental error, relative standard deviation, and the 95% UCL of the mean were determined following receipt of analytical results; all calculations were within acceptable parameters. The average DRO concentration was below the method 2 migration to groundwater cleanup level (230 mg/kg). This synopsis describes the procedures used and difficulties encountered and concludes that QC problems could cause DEC to reject the data under some circumstances, such as closing a site to a human health-based threshold. The random number generator worked well to establish 3-D independent sampling coordinates. A simpler method, and equally effective, would be to generate a random location for the first cell and apply that coordinate to all other cells.
http://www.dec.state.ak.us/spar/csp/guidance/mi_sampling_case_study.pdf

Catalytic DNA Biosensors for Radionuclides and Metal Ions with Parts-Per-Trillion Sensitivity and Million-Fold Selectivity
Liu, Juewen, Andrea K. Brown, Xiangli Meng, Donald M. Cropek, Jonathan D. Istok, David B. Watson, and Yi Lu
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). 64, 2007

The authors describe efforts to develop new catalytic DNA biosensors for simultaneous detection and quantification of bioavailable radionuclides such as uranium and technetium, and metal contaminants such as lead and mercury. The sensors will be highly sensitive and selective, not only for different metal ions, but also for different speciation states of the same metal ion. They will be applied to on-site, real-time assessment of concentration, speciation, and stability of the individual contaminants before and during bioremediation, and for long-term monitoring of DOE contaminated sites. To achieve this goal, we are employing a combinatorial method called "in vitro selection" to search from a large DNA library (~1015 different molecules) for catalytic DNA molecules that are highly specific for radionuclides or other metal ions, through intricate 3-dimensional interactions (such as in metalloproteins). Comprehensive biochemical and biophysical studies are being performed on the selected DNA molecules. The findings from these studies have helped to elucidate fundamental principles for designing effective sensors for radionuclides and metal ions. Based on the study, the DNA molecules have been converted to fluorescent or colorimetric sensors by attaching fluorescent donor/acceptor pairs or gold nanoparticles to them. Using the approach described above, we have obtained catalytic DNA sensors for Pb(II) and U(VI). The uranyl sensor has a detection limit of 45 pM or 11 parts-per-trillion, a dynamic range up to 400 nM, and selectivity of over one million-fold over other metal ions (J. Liu et al., Proc. Natl. Acad. Sci. USA 104, 2056–2061, 2007).These sensitivity and selectivity rival those of instrumental analyses. Application of the sensor in detecting uranium in contaminated soil samples from ERSD's Field Research Center (FRC) at Oak Ridge has also been demonstrated. This is the first time that uranium has been recruited as an enzyme cofactor, and the sensor rivals the most sensitive analytical instrument for uranium detection. This work shows that the in vitro selected catalytic DNA can be used as a general way of obtaining sensors for radionuclides and metal ions with ultrahigh sensitivity and selectivity.

Characterization of Ferricyanide-Humate Complexes by a Voltammetric Approach
Leita, L., A. Mori, G. Corso, M. De Nobili, I. Franco, and R.M. Cenci.
Soil and Sediment Contamination, Vol 10 No 5, p 483-496, 2001

Industrial sites that deal with the production and/or use of cyanide in their processes often have contamination problems in soils and water. The toxicity of cyanide and its fate in soil are strongly influenced by the formation of complexes with iron, such as ferric and ferrous cyanides. These complexes may interact with the soil inorganic fraction containing ferrous or ferric iron, with consequent formation of stable precipitates (ferric ferrocyanide or ferrous ferricyanide, the Prussian Blue and the Turnbull Blue, respectively), but no information is available on the capacity of humic substances to immobilize the cyano complexes and thereby reduce their toxicity, leaching, and potential contamination of the water table. One of the most significant properties of humic substances is their ability to interact with xenobiotics to form complexes of different solubility and chemical and biochemical stability. A voltammetric investigation was conducted to study the behavior of a ferricyanide/ ferrocyanide redox couple chosen as the

indicator of a redox system in the absence and in the presence of humic fraction at nominal molecular weight lower than 5 kDa (HSLMW). The results indicate that ferrocyanide/HSLMW and ferricyanide/HSLMW complexes are more stable than the parent Fe-CN- ones. These complexes undergo electrochemical processes involving a slow, homogeneous chemical reaction preceding the electron transfer step, which effectuate their kinetic control. Voltammetric measurements allowed the conditional constants K to be determined for ferric and ferrous cyanide/HSLMW complexes, respectively. These conditional constants are about three orders of magnitude higher than the constants for the ferricyanide and ferrocyanide complexes alone, respectively. From the data treatment, the authors hypothize that two humate ligands, on average, are accommodated in the coordination sphere of both iron (III) and iron (II) in the corresponding complexes
http://eusoils.jrc.it/ESDB_Archive/eusoils_docs/pub/382.pdf

Colorimetric and Fluorescent Sensing of SCN- Based on meso-Tetraphenylporphyrin/meso-Tetraphenylporphyrin Cobalt(II) System
Zhang, Y., H. Wang, and R.H. Yang.
Sensors, Vol 7 No 3, p 410-419, 2007

An approach for colorimetric and fluorescent sensing of thiocyanate (SCN-) has been proposed based on a competitive-displacement strategy between meso-tetraphenylporphyrin (TPP) and meso-tetraphenylporphyrin cobalt(II) (CoTPP). In a THF/water solution, TPP emits strong fluorescence at 651 nm; however, the fluorescence is quenched stepwise by CoTPP, and then restored by SCN-. The detection limit is 6.0 x 10(-4) M. Recognition of SCN- also could be achieved visually since the assembly system shows significant color change by the anion. Both the fluorescence and the color change of the system exhibit remarkably high selectivity to SCN- over a large series of anions. The interaction mechanisms among TPP, CoTPP, and SCN- were primarily investigated by fluorescence lifetime. The quenching of TPP fluorescence is attributed to the formation of TPP/CoTPP aggregates, and fluorescence restoration is due to the binding of CoTPP with SCN-, releasing the free TPP. This simple system has the potential to be used as a latent fluorescent sensing approach for SCN- for environmental analysis.
http://www.mdpi.net/sensors/list07.htm

Comparison of Naphthalene Measurements between Laboratory Methods and an Ultra-Fast Field Gas Chromatograph
Rezendes, A. (Alpha Analytical, Westboro, MA); M. Marando and P. King (GEI Consultants, Inc., Woburn, MA).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Several states (Massachusetts, New York, New Hampshire) have listed naphthalene as a target analyte in vapor intrusion guidance documents. U.S. EPA method TO-15 is preferred for detecting this compound, although naphthalene is not considered a volatile organic compound as the method defines it. The authors present the results of a side-by-side comparison of field and conventional laboratory analysis techniques for measuring naphthalene from a flux chamber. The zNose(r) Model 4200 Ultra-Fast Gas Chromatograph has been used for several years to monitor airborne naphthalene concentrations in real time during remedial activities. Results from the zNose(r) are compared with results for samples collected with evacuated canisters lined with fused silica and analyzed using TO-15, and samples collected on an PUF/XAD resin cartridge and analyzed by TO-13.

Compound Specific Isotope Analysis for Assessment and Quantification of Remedial Performance
Sherwood-Lollar, Barbara, Univ. of Toronto, Toronto, ON.
Abstracts: 2007 SERDP & ESTCP Partners in Environmental Technology Technical Symposium & Workshop, 4-6 December 2007

Compound-specific isotope analysis (CSIA) -- the characterization of stable isotope compositions of individual contaminant compounds dissolved in groundwater, sparked major advances in the application of isotope geochemistry to contaminant hydrogeology and remediation technologies. Stable isotope fingerprints, based first on carbon isotopes and then rapidly incorporating hydrogen and chlorine isotope information as well, now provide diagnostic tools to identify and differentiate sources of contamination. Perhaps the most significant impact of CSIA however has been that it provides a powerful new method for investigation of remediation potential at contaminated sites for both abiotic and biotic degradation processes. For organic contaminants such as chlorinated solvents, petroleum hydrocarbons, and fuel additives, degradation can involve large and reproducible kinetic isotope effects, producing systematic changes in the delta C-13 values of the residual contaminant as the light (C-12) versus heavy isotope (C-13) bonds are preferentially degraded, resulting in isotopic enrichment of the residual contaminant in C-13. This change in isotope ratios, or fractionation, can provide a diagnostic signal of degradation that can be used to monitor and evaluate performance. In many cases, stable isotope fractionation during degradation can be modeled by a simple Rayleigh distillation model that relates the change in observed stable isotope compositions to the extent of degradation in the system. Stable isotope analysis therefore can provide a direct indication of the effects of degradation on specific contaminants, as well as a novel independent means to quantify the extent of degradation and estimate degradation rates. Recent field studies illustrate the range of potential applications for CSIA, including both examples of the use of CSIA for quantification of biodegradation and the application of CSIA for diagnosis of degradation mechanisms.

Concentration of Tetrachloroethylene in Indoor Air at a Former Dry Cleaner Facility as a Function of Subsurface Contamination: A Case Study
Eklund, Bart M. (URS Corp., Austin, TX); Michelle A. Simon (U.S. EPA, Cincinnati, OH).
Journal of the Air & Waste Management Association, Vol 57 No 6, p 753-60, 2007

A field study was performed to evaluate indoor air concentrations and vapor intrusion (VI) of tetrachloroethene (PCE) and other chlorinated solvents at a commercial retail site in Dallas, Texas. The building once housed a dry cleaning operation. Results from an initial site characterization were used to select sampling locations for the collection of time-integrated canister samples for off-site analysis with U.S. EPA Method TO-15. PCE and other chlorinated solvents were measured in shallow soil gas, sub-slab soil gas, indoor air, and ambient air. The sub-slab soil gas exhibited relatively high values: PCE </= 2,600,000 parts per billion by volume

(ppbv) and trichloroethene </= 170 ppbv. The attenuation factor, the ratio of indoor air and sub-slab soil-gas concentrations, was unusually low: approximately 5 x 10(-6) based on the maximum sub-slab soil-gas concentration of PCE and 1.4 x 10(-5) based on average values. This paper presents the results of an unusually comprehensive site investigation at a former dry cleaning establishment that offer important insights into two issues debated among practitioners: (1) whether external soil-gas data are representative of sub-slab soil gas and (2) what constitutes a lower bound attenuation factor, which has been a pivotal issue in recent VI-related litigation. Paper at http://www.entrepreneur.com/tradejournals/article/165445153.html

Congener-Specific Analysis of PCBs by High Resolution GC with Low Resolution MS: The Need For a Standardized Method
Wagner, R.E., K. Lantiegne, A.C. Casey, J. Homrighaus, and R. Smith, Northeast Analytical, Inc., Schenectady, NY.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

The Aroclors (i.e., specific PCB congeners) were produced to contain a fixed-weight percent of chlorinated biphenyl to yield fluids that were useful in transformers, capacitors, heat transfer systems, hydraulic systems, and sealants. The PCB congener patterns exhibited by the original Aroclors can be measured accurately and routinely by traditional analytical techniques (GC/ECD), with pattern-matching the key tool in all routine methods of analysis. As PCBs entered the environment, changes occurred to the original PCB patterns that make routine determinative methods ineffective in accurate identification and quantification of PCB concentrations. Changes to the original PCB congener patterns have been mediated by mixing and evaporation, extensive biotransformation by bacteria, and alteration in the food web by bioaccumulation and enzymatic metabolism. PCBs also can exist with other environmental contaminants, such as pesticides, chlordane, toxaphene, PCTs, and PCNs, that interfere with measurement by routine techniques. The authors present information on development of a gas chromatographic low-resolution mass-spectrometry method. Sample types that have been difficult to analyze by traditional GC/ECD techniques are discussed. Information also is provided on the use of certified standard reference materials and the accuracy of the proposed method in quantifying PCB congeners. The sensitivity of the method is demonstrated by employing large volume injection techniques to analyze low concentration samples.

Contouring of Subsurface NAPL Accumulations with Surface Radon Measurements
Ortega, M.F., J.E. Garcia-Gonzalez, L.F. Mazadiego, and E. De Miguel, ETSI Minas Madrid, Univ. Politecnica de Madrid, Spain.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

The use of non-intrusive, time-efficient surface techniques, i.e. soil vapor analysis, geophysical methods and radon measurements (emanometry) can provide cost-effective characterization approaches at NAPL sites. Field experimental results show that the activity of radon-222 decreases significantly above NAPL pools due to radon's preferential partition into the organic phase, and also that the boundaries of the free-phase plume are marked by an increase of radon signal above local background levels due to the accumulation and subsequent decomposition of uranium in the reducing environment around hydrocarbon pools. Because the diffusivity of radon in the subsurface is higher than that of most volatile organic compounds, emanometry is considerably less sensitive to depth and soil heterogeneity than surface soil-gas measurements, and is applicable even when the amount of organic vapor reaching the ground surface is very low or non-existent. The evidence suggests that radon monitoring can be used effectively to draw the surface trace of NAPL accumulations for a wide range of pollutants, even in difficult geologic environments.

Coupled Biogeochemical Process Evaluation for Conceptualizing Trichloroethylene Co-Metabolism
Radtke, Corey, Deborah Newby, David Reed, Mark Delwiche, Ronald L. Crawford, Andrzej Paszczynski, Ravi Paidisetti, Mark Conrad, Eoin Brodie, Hope Lee, Robert Starr, Dana Dettmers, and Frederick S. Colwell
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 75, 2007

Our research focuses on the coupled biogeochemical processes that dictate the rate of methane-driven co-metabolism of trichloroethene (TCE) in the Snake River Plain aquifer at the Idaho National Laboratory. Natural attenuation has been accepted as a remediation strategy at this location, and our study seeks to quantify the contribution of methanotrophs to the natural attenuation and to obtain various lines of evidence that indicate that the process is occurring. Aquifer microbial communities and chemistry from within the TCE plume were characterized using water samples from wells and biofilm communities from in situ incubation of basalt chips. Methanotrophic microbes, or evidence of their activity, were detected in numerous wells in the "medial zone" of the TCE plume, where TCE concentrations ranged up to 500 ppb. Combined analyses using fluorescent in situ hybridization (FISH), enzyme activity probes, Phylochip community characterization and community proteomics targeting the methanotroph-specific soluble methane monooxygenase both detected evidence of methanotrophs in the groundwater and in biomass obtained from basalt chips. Phylochip analyses also indicated the presence of several methanogenic genera in the wells, suggesting that biogenic methane may contribute to methanotroph sustenance in the aquifer. Additionally, the catalytic subunit of soluble methane monooxygenase (mmoX) has been detected in concentrated groundwater by conventional PCR. As yet, laboratory incubations of aquifer samples have not determined that co-metabolism of TCE is occurring in any of the samples analyzed; however, based on estimates derived from computational modeling of the rates of natural attenuation, we expect that these rates may be difficult to detect in relatively short-term incubations of aquifer communities. Currently, flow-through in situ reactors are incubating at two distinct aquifer flow rates, to determine the affect of hydraulic flow on the microbial communities capable of TCE co-metabolism. Subsequent studies will assess the contribution of methane in TCE co-metabolism carried out by the reactor communities. Determination of the TCE co-metabolism rate, at different methane concentrations and groundwater flow velocities, will yield key modeling parameters for the computational simulations that describe the attenuation, and accordingly improve the predictive capability of the models. Accurate assessment of natural attenuation rates under different aquifer conditions will further justify the use of natural attenuation at the INL and at other DOE sites.

Cross-Reactive Sensor Array for Metal Ion Sensing Based on Fluorescent SAMs
Basabe-Desmonts, L., F. van der Baan, R.S. Zimmerman, D.N. Reinhoudt, and M. Crego-Calama, Univ. of Twente, The Netherlands.
Sensors, Vol 7 No 9, p 1731-1746, 2007

Fluorescent self assembled monolayers (SAMs) on glass were developed as new sensing materials for metal ions. These fluorescent SAMs comprise fluorophores and small molecules sequentially deposited in a monolayer on glass. The preorganization provided by the surface avoids the need for complex receptor design, allowing for a combinatorial approach to sensing systems based on small molecules. This paper describes the fabrication of an effective microarray for the screening of metal ions and the properties of the sensing SAMs. A collection of fluorescent sensing SAMs was generated by combinatorial methods and immobilized on the glass surfaces of a custom-made 140-well microtiter plate. The resulting libraries are easily measured and show varied responses to a series of cations, such as Cu2+, Co2+, Pb2+, Ca2+, and Zn2+. These surfaces are not designed to complex a unique analyte selectively but instead are intended to produce fingerprint-type responses to a range of analytes by less specific interactions. The unselective responses of the library to the presence of different cations generate a characteristic pattern for each analyte -- a "fingerprint" response.
http://www.mdpi.net/sensors/list07.htm

Demonstration and Validation of a Regenerated Cellulose Dialysis Membrane Diffusion Sampler for Monitoring Groundwater Quality and Remediation Progress at DoD Sites
Trotsky, J. (NFESC, Port Hueneme, CA); T. Imbrigiotta (U.S. Geological Survey).
Abstracts: 2007 SERDP & ESTCP Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, December 4-6, 2007

Dialysis membrane diffusion samplers are a promising alternative type of diffusion sampler. These samplers are made of regenerated-cellulose dialysis membrane material and have an advantage over polyethylene diffusion bag (PDB) samplers in that they can be used for both dissolved inorganic and dissolved organic chemicals (volatile/nonvolatile) sampling in ground water. PDB samplers have been validated for the measurement of most VOCs; however, PDBs are limited in sampling all VOCs or any common soluble inorganic constituents. Recently developed in-well dialysis membrane diffusion samplers show promise for greatly reducing monitoring costs by eliminating much of the time needed at the wellhead and by minimizing the production/treatment of purge water. The objectives of this project are to demonstrate and validate in coordination with the Interstate Technology and Regulatory Council (ITRC) how long it takes for dialysis membrane diffusion samplers to equilibrate with groundwater concentrations of a range of inorganic and organic constituents and to compare the results of field samples collected using these samplers with samples collected using the standard low-flow purging technique. Bench-scale testing has shown that dialysis samplers equilibrated within 3 to 7 days for most cations and trace metals and within 1 to 3 days for anions, silica, methane, dissolved organic carbon, and all VOCs (including MTBE). Dialysis samplers equilibrated in essentially the same time period at lower concentrations as they did at higher concentrations. Lower temperatures were found to have a small effect in lengthening equilibrium times for several inorganic constituents from 3 days to 7 days. Groundwater temperatures across the continental

U.S. vary within the boundaries of the temperatures tested so these findings should have transfer value to most sampling locations. Field-comparison testing has shown high correlations between the concentrations of most inorganic and organic parameters collected with dialysis samplers and the concentrations of these same constituents collected with low-flow purging. Comparability is best when the dialysis sampler is positioned at the depth of the highest mass flux of a contaminant into the screened or open interval of a well. The ITRC Diffusion Sampling Team intends to publish a new document that includes the protocols of using dialysis membrane diffusion samplers. The project has recently expanded to include testing the dialysis membrane diffusion sampler on perchlorate and ordnance compounds. Bench-scale testing and field comparison sampling are underway.

Design of a Selective and Sensitive PVC-Membrane Potentiometric Sensor for Strontium Ion Based on 1,10-Diaza-5,6-benzo-4,7-dioxacyclohexadecane-2,9-dioneas
Shamsipur, Sayed, Yahya Kazemi, and Hashem Sharghi.
Sensors, Vol 7 No 4, p 438-447, 2007

A novel PVC membrane sensor for the Sr2+ ion based on 1,10-diaza-5,6-benzo-4,7-dioxacyclohexadecane-2,9-dione possesses a Nernstian slope of 30.0 +/- 0.6 mV/decade over a wide linear concentration range of 1.6 x 10(-6)-3.0 x 10(-3) M with a detection limit of 6.3 x 10(-7) M. It has a fast response time of <15 s and can be used for at least two months with no major decline in potential. The potentiometric response is independent of the test solution pH in the pH range 4.3 to 9.4. The proposed electrode shows good selectivities over a variety of alkali, alkaline earth, and transition metal ions.
http://www.mdpi.net/sensors/list07.htm

Detailed Group-Type Characterization of Petroleum Hydrocarbons Using HPLC Fractionation Followed by GC×GC for Assessment of Remediation Potential of Oil Contaminated Soils
Mao, Debin, Hendrik Van De Weghe, Ludo Diels, Nicole De Brucker, and Richard Lookman.
14th Annual International Petroleum Environmental Conference, 6-9 November 2007, Houston, Texas. 19 pp (PowerPoint pdf), 2007

To assess the necessity of conducting a remediation project and to select an appropriate remediation technology, it is necessary to collect sufficient information to determine the toxicity, degradability, mobility, solubility, and remediation potential of the contaminants. The authors discuss a new method: oil characterization based on comprehensive 2-D gas chromatography (GCxGC) with FID. Tests of the method show excellent quantitative characterization of oils, a wide application range, good detectability, good reproducibility, and suitability for routine analyses. Petroleum hydrocarbons can be separated into alkane, cycloalkane, alkene, and (poly)aromatic groups (PIONA) which could be divided further by boiling point or carbon numbers. Hydrocarbons from C8 to C40 can be characterized by this method, and detectability is comparable with the direct GC×GC method. Analysis requires less than 15 min of fractionation time, one HPLC column, and a simple solvent change. The characterization results can be linked to water solubility, (bio)degradability, and toxicity to allow prediction of the remediation potential of oil pollution at a site. The procedure also is useful for investigating the mechanisms and the efficiency of different remediation technologies or treatment products.
http://ipec.utulsa.edu/Conf2007/2007agenda.html

Detection of Microbial Sulfate-Reduction Associated with Buried Stainless Steel Coupons
Delwiche, M., A. Olson, and K. Adler-Flitton, Idaho National Laboratory.
INL/CON-06-11127, 12 pp, 2007 [Presented at Corrosion NACExpo 2007]

A study was conducted to demonstrate the applicability of an innovative radioactive isotope method for imaging microbial activity in geological materials to assess metal corrosion. The method was tested on a sample of stainless steel coupons that had been buried as part of a corrosion study initiated in 1970 by the National Institute of Standards and Testing (NIST). The images showed that evidence of microbial activity could be mapped on a millimeter scale to coupon surfaces. A second more conventional isotope tracer method was used to provide a quantitative measure of the same type of microbial activity in soil proximal to the buried coupons. Together, the techniques offer a method for evaluating low metabolic levels of activity that have the potential for significant cumulative corrosion effects. The methods are powerful tools for evaluating the potential for microbially induced corrosion of buried steel components used in pipelines, the power and communications infrastructure, and nuclear waste repository containers.
http://www.inl.gov/technicalpublications/Documents/3644024.pdf

Detection of Trace Organophosphorus Vapor with a Self-Assembled Bilayer Functionalized SiO2 Microcantilever Piezoresistive Sensor
Zuo, Guomin, Xinxin Li, Peng Li, Tiantian Yang, Yuelin Wang, Zhenxing Cheng, and Songlin Feng, Chinese Academy of Sciences, Shanghai, China.
Analytica Chimica Acta, Vol 580 No 2, p 123-127, 24 Nov 2006
Using piezoresistive SiO2 microcantilever technology, we present an ultra-sensitive chemical sensor for trace organophosphorus vapor detection. A self-assembled composite layer of Cu2+/11-mercaptoundecanoic acid is modified on the surface of the sensing cantilever as a specific coating to capture PO containing compounds. Experimental results indicate that the sensor can be quite sensitive to DMMP vapor (well known as a simulant of nerve agent). The signal-noise-limited detection resolution of the sensor is experimentally obtained as low as several parts per billion. Besides that the sensor can yield reversible and repeatable response to DMMP vapor, adsorption of DMMP on the self-assembled composite layer is well fit to the Langmuir isotherm model.

Determination of Chromium(III) in Wastewater Samples Using Potentiometric Membrane Sensor
Zamani, H.A., Islamic Izad Univ., Quchan, Iran.
CEST2007: Proceedings of the 10th International Conference on Environmental Science & Technology, 5-7 September 2007, Kos Island, Greece. p A-1631-1637, 2007

A selective and sensitive PVC membrane sensor has been developed as a Cr(III) ion selective electrode using the ionophore 1,3-diamino-2-hydroxypropane-N,N,N',N'-tetraacetic acid (DPTA). The sensor displays a linear dynamic range between 7.0 x 10(-7) and 1.0 x 10(-1) M, with a near Nernstian slope of 19.8 +/- 0.3 mV per decade and a detection limit of 2.0 x 10(-7) M. The best performance was obtained with a membrane composition of 32% polyvinyl

chloride, 57.5% nitrophenyl octyl ether, 3% sodium tetraphenyl borate, and 7.5% DPTA. The potentiometric response of the proposed electrode is pH independent in the range of 2.5 to 6.8. The sensor possesses the advantages of short conditioning time, fast response time (<10 s) and good selectivity toward transition and heavy metals, as well as some mono, di-, and trivalent cations. The electrode can be used for at least 10 weeks with little divergence in potential. It was used effectively as an indicator electrode in the potentiometric titration of Cr(III) ions with EDTA and also in Cr(III) determination in wastewaters of chromium electroplating industries.
http://www.srcosmos.gr/srcosmos/generic_pagelet.aspx?pagelet=Article%20summary&pub_id=9872

Development and Electrochemical Investigations of an EIS- (Electrolyte-Insulator-Semiconductor) Based Biosensor for Cyanide Detection
Turek, M., L. Ketterer, M. Classen, H.K. Berndt, G. Elbers, P. Krueger, M. Keusgen, and M.J. Schoening.
Sensors, Vol 7 No 8, p 1415-1426, 2007

A cyanide biosensor based on a pH-sensitive, p-doped electrolyte-insulator-semiconductor (EIS) structure with an immobilised enzyme (cyanidase) has been realized at the laboratory scale. The immobilization of the cyanidase is performed in two distinct steps. First, the covalent coupling of cyanidase to an N-hydroxysuccinimide (NHS)-activated Sepharose(tm) gel, followed by the physical entrapment of NHS-activated Sepharose(tm) with the immobilized cyanidase in a dialysis membrane onto the EIS structure. The immobilization of the cyanidase to the NHS-activated Sepharose(tm) was studied by means of gel electrophoresis measurements and investigations using an ammonia-selective electrode. Capacitance/voltage and constant capacitance measurements have been carried out for the electrochemical characterization of the cyanide biosensor. A differential measurement procedure is presented to evaluate the cyanide concentration-dependent biosensor signals.
http://www.mdpi.net/sensors/list07.htm

Development of a Field Method for Identification of Acid-Generating Mining Wastes Using Portable XRF Technology
Bell, K. and T. McComb (Barge, Waggoner, Sumner and Cannon, Inc., Nashville, TN); F. Miller (Glenn Springs Holdings, Inc., Lexington, KY); M. Bowers (Secaps Environmental, Inc., Fuquay-Varina, NC).
2007 SME Annual Meeting & Exhibit and 109th National Western Mining Conference, Denver, Colorado, 25-28 February 2007

Acid-base accounting (ABA) is a static test commonly used in the prediction of acid production from mine wastes, but ABA is expensive and time-consuming. To make rapid decisions during phased remedial actions at the Copper Basin Mining District Site, a field method was developed to identify acid-generating materials. A site-specific relationship between sulfur and acid-generating potential was defined for site materials. Emerging portable x-ray fluorescence technology is being used to measure sulfur in the field for real-time identification of acid-generating materials. Qualified field personnel can make rapid on-site decisions on removal of materials, thus minimizing sample collection and analysis.

Development of a Surface Plasmon Resonance n-Dodecane Vapor Sensor
Munoz Aguirre, N., L. Martinez Perez, J.A. Colin, and E. Buenrostro-Gonzalez.
Sensors, Vol 7 No 9, p 1954-1961, 2007

A surface plasmon resonance sensor for detecting n-dodecane vapor was developed using a high-density polyethylene thin film layered over gold. Preliminary results are presented to show that samples in the range of a few hundred ppm(V) of n-dodecane vapor in butane gas can be sensed. Studying the response as a function of time, the sensing process is quickly reversible.
http://www.mdpi.net/sensors/list07.htm

Development of QCM Trimethylamine Sensor Based on Water Soluble Polyaniline
Li, G., J. Zheng, X. Ma, Y. Sun, J. Fu, and G. Wu.
Sensors, Vol 7 No 10, p 2378-2388, 2007

A rapid, sensitive, low-cost device to detect trimethylamine is presented. After the preparation of a water-soluble polyaniline film, the polyaniline was characterized via Fourier transform infrared spectroscopy (FTIR), UV-visible spectroscopy, and scanning electron microscopy. Based on the water-soluble polyaniline film, a quartz crystal microbalance (QCM) sensor for trimethylamine detection was fabricated and its characteristics were examined. The sensor consisted of one quartz crystal oscillator coated with one polyaniline film for sensing and another one for reference. Pretreated with trimethylamine, the QCM sensor had an excellent linear sensitivity to trimethylamine. Easily recovered by N2 purging, the response of the sensor exhibited good repeatability. Responses of the sensor to trimethylamine, ethanol, and ethyl acetate were compared, and the results showed that the response was related to the polarity of the analyte vapor. Experimental results also showed that the sensitivity of the sensor was relatively stable for about one month. The simple method for preparing and coating the polyaniline sensing film makes it promising for mass production.
http://www.mdpi.net/sensors/list07.htm

Diel Cycling of Zinc in a Stream Impacted by Acid Rock Drainage: Initial Results from a New In Situ Zn Analyzer
Chapin, T.P., D. A. Nimick, C.H. Gammons, and R.B. Wanty
Environmental Monitoring and Assessment, Vol 133 Nos 1-3, p 161-167, 2007

Historically, scientists have assumed that a properly collected water sample will provide an accurate assessment of constituent concentrations in a water body on a given day assuming constant hydrologic conditions. However, an increasing body of evidence indicates that the concentration of many potentially toxic trace elements (such as As, Cd, Cu, Mn, Zn) in streams can vary over a large range (up to 500 percent) during a 24-hour period irrespective of changes in streamflow. These diel concentration cycles have been shown to be robust and reproducible, having been documented in many streams separated by large distances, in different geologic environments, and over a large range of metal concentrations (Nimick and others, 2003). Diel cycles in trace-metal concentrations are controlled primarily by chemical and biological processes that respond to the daily cycle of sunlight and darkness. These processes transfer metals between solution and solid phases in the water column or streambed, thus causing diel metal cycles. To investigate this phenomenon, the authors have developed an instrument that can continuously monitor in situ zinc concentrations in near real-time. They present initial results from a 3-day deployment at Fisher Creek, Montana and suggest that longer deployments to examine the effects of episodic events such as rainstorms and snowmelt pulses on zinc loading in streams affected by acid rock drainage are possible.

Differentiation of Hazardous Indoor Molds via Canine Detection and SPME-GC/MS
Griffith, R.T., K. Jayachandran, W. Whitstine, and K.G. Furton.
Sensors, Vol 7 No 8, p 1496-1508, 2007

As they grow, indoor molds produces several types of primary and secondary metabolites, including microbial volatile organic compounds (MVOCs). Microbial volatile organic compound emission can be used as a preliminary indication of a mold infestation that is invisible to the unaided eye. The objective of the study is to identify the unique odor signatures of three species of molds--Aspergillus versicolor, Penicillium chrysogenum, and Stachybotrys chartarum--by SPME-GC/MS analysis. Determining the compounds emitted by the selected species has made it possible to conduct validation studies of canine detection of these mold species through a series of field tests.
http://www.mdpi.net/sensors/list07.htm

Digital Spectral Reflectance Data of Fe-Oxide, Fe-Hydroxide, and Fe-Sulfate-Hydrate Minerals Associated with Sulfide-Bearing Mine Wastes
Crowley, J.K., D.E. Williams, J.M. Hammarstrom, N. Piatak, J.C. Mars, and I-Ming Chou.
U.S. Geological Survey Open-File Report 03-196, 2006

Fifteen Fe-oxide, Fe-hydroxide, and Fe-sulphate-hydrate mineral species commonly associated with sulphide bearing mine wastes were characterized using X-ray powder diffraction and scanning electron microscope methods. Diffuse reflectance spectra of the samples show diagnostic absorption features related to electronic processes involving ferric and/or ferrous iron, and to vibrational processes involving water and hydroxyl ions. Such spectral features enable field and remote sensing based studies of the mineral distributions. Because secondary minerals are sensitive indicators of pH, Eh, relative humidity, and other environmental conditions, spectral mapping of these minerals promises to have important applications to mine waste remediation studies. This report releases digital (ascii) spectra (spectral_data_files.zip) of the fifteen mineral samples to facilitate usage of the data with spectral libraries and spectral analysis software. The spectral data are provided in a two-column format listing wavelength (in micrometers) and reflectance, respectively. http://pubs.usgs.gov/of/2003/196/

Electrochemical Method for the Rapid on Site Screening of Cadmium and Lead in Soil and Water Samples
Cooper, J., J.A. Bolbot, S. Saini, and S.J. Setford, Cranfield Univ., Silsoe, Bedfordshire, UK.
Water, Air, & Soil Pollution, Vol 179 Nos 1-4, p 183-195, Feb 2007

Single-use sensors have been fabricated using an inexpensive screen-printing (thick film) technology. Coupled with differential pulse anodic stripping voltammetry (DPASV), these electrodes have provided a rapid, inexpensive on-site screening device for the simultaneous field-based determination of cadmium (Cd) and lead (Pb) in soil and water samples in the microgram per liter/kilogram range. A simplified soil extraction procedure using 1 mol/L aqua regia and a 3 min ultrasonic sample agitation has been developed to allow field-based device usage. Recoveries of 64% and 52% for Cd and Pb, respectively, were obtained, with a relative standard deviation (RSD) of < 8% for both analytes (n = 10). Analytical data are also reported for copper, but significant peak distortions reduce the confidence of the method for this metal. Results indicate that the combined extraction/DPASV method yields semi-quantitative data for rapid field-based site screening purposes.

Electrodeposited and Sol-Gel Precipitated p-type SrTi(1-x)Fe(x)O(3-delta) Semiconductors for Gas Sensing
Sahner, Kathy, Perena Gouma, and Ralf Moos.
Sensors, Vol 7 No 9, p 1871-1886, 2007

Three methods were investigated for the preparation of nanoscale SrTi(1-x)Fe(x)O(3-delta) sensor films for hydrocarbon sensing. In addition to screen-printed thick films based on sol-precipitated nanopowders, two novel synthesis methods, electrospinning and electrospraying, were tested successfully. All of these sensor devices showed improved sensor functionality in comparison to conventional microscale thick films. To explain the impact of the enhanced surface-to-volume ratio on sensor properties in a quantitative way, a mechanistic model was applied to micro- and nanoscaled devices. In contrast to the conventional diffusion-reaction model that has been proposed for n-type semiconducting sensors, it contained novel approaches with respect to the microscopic mechanism. With very few fit variables, the model was found to represent effectively the sensor functionality of p-type conducting SrTi(0.8)Fe(0.2)O(3-delta) films. In addition to the temperature dependency of the sensor response, the effect of the specific surface area on the sensor response was predicted.
http://www.mdpi.net/sensors/list07.htm

Electrokinetically Enhanced Bioremediation of Creosote-Contaminated Soil: Laboratory and Field Studies
Suni, Sonja; Essi Malinen, Jarmo Kosonen, Hannu Silvennoinen, and Martin Romantschuk
Journal of Environmental Science and Health - Part A Toxic/Hazardous Substances and Environmental Engineering, Vol 42 No 3, p 277-287, 2007

This study investigated the effects of applying heat and nutrients to creosote contaminated soil at a former wood treater. A pilot laboratory study was done on soils from two areas. One was a highly polluted soil from a marsh next to the treatment plant and the other a less polluted soil near the base of one of the plant buildings. This study indicated that the more contaminated soil experienced a greater percent reduction than the less contaminated soil. The field test was performed on an approximately 100 cubic meter plot where the less contaminated soil had been taken. Nutrient and oxygen levels in the soils were elevated by hydraulic and electrokinetic pumping of urea and phosphate amended, aerated water into the soil. Followed by the application of a DC current which raised the soil temperature from 6° C to between 15° and 50° C. During the three months of treatment, total PAH concentrations dropped by 50-80%, while mineral oil concentrations decreased approximately 30%.

Environmental Assessment of Lead at Camp Edwards, Massachusetts, Small Arms Ranges
Clausen, J.L., and N. Korte.
ERDC/CRREL TR-07-11, 136 pp, Aug 2007

Environmental issues for small arms training with lead (Pb) projectiles are examined in this report for Camp Edwards, MA, to evaluate whether past or future use of lead in small arms has resulted or will result in Pb mobilization to groundwater. The literature demonstrates that Pb mobilization occurs chiefly by wind and surface water erosion, generally not by dissolution and leaching through soil. Environmental conditions at Camp Edwards dictate that wind and surface water are not primary avenues of transport, due to extensive vegetative cover and highly permeable soils. Highly permeable soils limit corrosion of metallic Pb but can facilitate transport for dissolved forms. Because highly permeable soils favor transport, careful analysis of the geochemical conditions with respect to Pb vertical transport to groundwater was a focus for this study. It is the conclusion of this study that Pb has not contaminated the groundwater in any significant way based on the absence of Pb plumes. Only one groundwater monitoring well associated with the small arms ranges had a single low lead detection of < 2 ppb.
http://www.crrel.usace.army.mil/library/technicalreports/TR-07-11.pdf

EPA Method 8330B: Data Quality Impact on the Characterization of Energetic Residues on Military Training Ranges
Hewitt, A.D., T.F. Jenkins, M.E. Walsh, M.R. Walsh, and S. Bigl (U.S. Army ERDC-CRREL); M. Chappell (ERDC/EL); C.A. Ramsey (EnviroStat, Inc.).
Abstracts: 2007 SERDP & ESTCP Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, December 4-6, 2007

Experiences gained through more than 25 training firing range studies conducted by ERDC-CRREL and others led to modifications of EPA Method 8330 published as Method 8330B in which techniques are described that allow scientifically defendable project data quality objectives to be achieved. Energetic residues are distributed heterogeneously over military training ranges as particles of various sizes, shapes, and compositions. Most energetic residues are deposited on the surface, and the highest concentrations exist at firing positions, near targets, and where demolition activities are performed. In the case of impact and demolition ranges, the greatest quantities of residues are from rounds that fail to detonate as designed. To address the compositional and distributional heterogeneity associated with the distribution of particles and to obtain representative mean energetic residue soil concentrations, the sampling strategy must strive for the acquisition of samples that contain the constituents of concern in the same proportion to the bulk matrix as exists within the decision unit (sampled area, population, exposure unit). This objective has been achieved frequently with samples of mass greater than 1 kg composed of 30 or more increments that have been collected starting at a randomly selected position followed by evenly spaced locations throughout the sampling area. To ensure that the subsample taken for analysis of energetic residues is representative of the sample, the field sample must be processed thoroughly. This objective has routinely been accomplished when the entire sample was air-dried, sieved, and the less than 2-mm portion mechanically pulverized prior to splitting or sub-sampling. This procedure is especially critical for firing point samples due to the polymeric composition of the particles. To promote conformity among various government agencies, ESTCP held three open workshops, two open field demonstration projects, and gave numerous invited presentations to different government agencies. This presentation summarizes the sampling and sample-processing protocols recommended in Method 8330B, highlighting their impacts on data quality and risk assessment through the application of Pro UCL.

Evaluating Flow and Transport Through Macroporous Soils: An Innovative Approach to Using the Tension Infiltrometer

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Geological Society of America Abstracts with Programs, Vol 39 No 6, p 113, Paper 41-10, 2007

A novel approach to using a tension infiltrometer was employed to investigate macropore (e.g., fractures, animal burrows, and root holes) flow and transport processes at two field sites in southern Ontario. A series of equal-volume infiltration experiments were conducted at different tensions to enhance (small tensions) or limit (large tensions) the degree of macropore flow. Dye and fluorescent microsphere tracers were applied in all tests as surrogates for dissolved and colloidal contaminant species, respectively. Upon completion of infiltration, excavations were completed to examine the dye-stained flow patterns, map soil and macropore features, and collect soil samples for analysis of microspheres. Linear macropores, in the form of earthworm burrows and root holes, were the most prevalent macropore type at both sites. The relationship was evident between the vertical extent of infiltration and the applied tension as a result of preferential flow along macropores. Under the smallest applied tensions (<1.0 cm), dye staining was observed between 0.7 and 1.0 m depth, although only a fraction of the visible macropores contributed to flow at these depths. On all excavated sections, the dye patterns correlated reasonably well with the presence of microspheres in the soil samples. The tension infiltrometer was also used to infiltrate dye along an exposed vertical soil face, thereby providing a rare opportunity to directly observe transient macropore flow processes. The resulting vertical flow velocities within the macropores were on the order of tens of meters per day, illustrating the rapid connection between surface water and groundwater, even under partially saturated conditions. Overall, the tension infiltrometer performed extremely well as a tool for controlling macropore flow in situ, and together with the dye and microsphere tracers, provided unique and valuable insights into small-scale flow and transport behavior.

Evaluation of Acid-Generating Potential of Complex Mine Wastes

Levitan, D.M., R.R. Seal II, N.M. Piatak, and J.M. Hammarstrom, USGS, Reston, VA.
Geological Society of America Abstracts with Programs, Vol 39 No 6, p 404, Paper 145-4, 2007

Acid-base accounting (ABA) is a static test commonly used in the prediction of acid production from mine wastes. In standard ABA, acid-generating potential (AP) is calculated from total sulfur content; modified ABA uses sulfide sulfur. It is assumed in the calculation of AP that the measured sulfur is derived from pyrite, though this calculation can be inaccurate in mine wastes containing other sulfur-bearing minerals, such as jarosite, pyrrhotite, gypsum, and sulfate salts. The investigators used a variety of leaching techniques on a representative suite of metal mine-waste samples (total S: 0.7 to 27 Wt. %) and mineral separates to understand the behavior of these minerals and to determine accurate AP values. Six non-sequential leaches included water for soluble salts--both dilute and concentrated HCl targeting gypsum, jarosite, and pyrrhotite; Na2CO3 for gypsum and jarosite; NaOH for all sulfates; and HNO3 for pyrite. Qualitative and quantitative x-ray diffraction (XRD), sulfur measurements on solid residues, and sulfate measurements of leachates were used to assess the persistence of sulfur-bearing minerals following these leaches. XRD showed removal of jarosite by boiled concentrated HCl, Na2CO3, and NaOH, respectively; removal of pyrrhotite by boiled concentrated HCl; and removal of gypsum by boiled concentrated HCl, Na2CO3, and HNO3, respectively. Incomplete removal of gypsum was seen following dilute HCl and NaOH treatments. In samples with high pyrite content, pyrite persisted throughout all the leaches, though a decrease in sulfur concentration was seen in samples treated with HNO3. It is possible to distinguish the sulfides pyrite and pyrrhotite through a boiled concentrated HCl leach and to separate these sulfides from sulfates like jarosite and gypsum through a Na2CO3 leach. Gypsum and jarosite can be differentiated through a HNO3 leach. These results suggest that current widely accepted ABA protocols could yield inaccurate results, depending upon the mineralogy of mine wastes. Interpretation of ABA results can be improved through mineralogical studies of mine wastes and through modifications to leaching protocols.

Evaluation of Airborne Remote Sensing Techniques for Predicting the Distribution of Energetic Compounds on Impact Areas

Graves, M.R., L.P. Dove, T.F. Jenkins, S. Bigl, M.E. Walsh, A.D. Hewitt, D. Lambert, N. Perron, C. Ramsey, J. Gamey, L. Beard, W.E. Doll, and D. Magoun.

ERDC-TR-07-13, 202 pp, Sep 2007

The characterization of impact area munitions constituents typically has employed traditional soil sampling approaches. These sampling approaches do not account accurately for the distribution of such contaminants over the landscape due to the distributed nature of explosive compound sources throughout impact areas, the highly localized distribution of contaminants surrounding these sources, and inaccurate records of historical target locations. Remote sensing and geographic information system (GIS) technologies were utilized to assist in the development of enhanced sampling strategies to predict the landscape-scale distribution of energetic compounds. Remotely sensed magnetometer and electromagnetic (EM) data were used to detect and delineate areas of high densities of anomalies. The anomalies were considered to be related to targets and/or ranges likely to be highly contaminated with surface and subsurface ordnance and explosive items and artifacts. The Oak Ridge Airborne Geophysical System airborne magnetometer and time-domain EM systems were used. The magnetometer data were analyzed using GIS technology to develop a soil sampling plan based on varying levels of metal content in the ground. Soil samples were then collected and analyzed for energetic compounds. Statistical techniques found a possible relationship (correlation) between the analytic signal and the energetics measured in the soil.

http://handle.dtic.mil/100.2/ADA472264

Evaluation of Bioremediation Applicability to Contaminated Sites with Low Hydraulic Conductivity: A Case Study of the Contaminated Banks of the Mahoning River, Northeastern Ohio

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Geological Society of America Abstracts with Programs, Vol 39 No 6, p 62, Paper 22-14, 2007

The Mahoning River is contaminated mainly by PAHs, PCBs, and heavy metals. It is considered one of the five most contaminated rivers in the United States. Bioremediation is being considered, among other options, to remediate the contaminated banks along a stretch of the Mahoning River where contaminant levels are particularly high. The banks consist of heterogeneous sediments made of fine-grained sand, silty and clayey sand, silt, and clay. The low hydraulic conductivity of the sediments will limit the implementation of bioremediation, which is only applicable if the hydraulic conductivity of the contaminated medium is greater than 10(-4) cm/sec. The hydraulic conductivity of the banks was characterized vertically and horizontally using a quick and inexpensive approach based on sediment-size analysis to determine the technical feasibility of bioremediation. Over 80 samples were analyzed for hydraulic conductivity by the Hazen formula. The samples were obtained at three locations from 19 boreholes drilled by a hand auger in both banks of the Mahoning River. Hydraulic conductivity values ranged at the three sites from 6.25x10(-4) to 1.00x10(-2), 2.25x10(-4) to 1.23x10(-3), and 2.25x10(-4) to 2.03x10(-3) cm/sec, respectively, with geometric mean values of 1.62x10(-3), 5.23x10(-4), and 1.00x10(-3) cm/sec. These values, which are reflective of a lithology dominated by silty/clayey sand and clean fine-grained sand, clearly show that bioremediation is technically feasible for the three sites based on hydraulic conductivity values.

Evaluation of Pneumatically Induced Fractures for Enhanced Delivery of Substrates within Low Permeable Soils
Liskowitz, M. (ARS Technologies, Inc., New Brunswick, NJ); C. Riis and A. Christensen (NIRAS, Allerod, Denmark).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

A pilot-scale investigation was performed in December 2005 at a site in Hedehusene, Denmark, to assess the effectiveness of pneumatic fracturing technology as a permeability/hydraulic conductivity enhancer and delivery mechanism to augment reagent and/or substrate distribution within formations of low permeability. The results generated from the study were used to ascertain the fracturing characteristics and/or mechanism through evaluation of achievable radius of influence, uniformity, and apparent density of the induced fracture network within a clayey till. Fracture mapping was accomplished using different tracers injected with the nitrogen gas used during the fracturing process. The tracers provided visual identification of the fractures at various distances and depths from the fracturing well, allowing documentation of the actual radius of influence, mass balance, and fracture density obtained through pneumatic fracturing. The results identified induced fractures in core samples taken at distances of up to 3 meters from the fracturing well. The use of digital imaging under UV light proved an efficient method to locate the fractures in the core samples. A preliminary mass balance indicated that 90% of the tracer mass was distributed within 1 to 2 meters from the fracturing well. Distinct fractures with high concentrations of tracers were observed over the entire fracturing interval (3 to 8 meters bgs) at distances up to 6.8 meters from the fracturing well.

Evaluation of Vapor Intrusion Impacts Using Induced Building Depressurization
McHugh, T. and T. Nickels (GSI Environmental, Houston, TX); K. Gorder (Hill AFB); S. Brock (AFCEE).
Abstracts: 2007 SERDP & ESTCP Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, December 4-6, 2007

Many vapor intrusion guidance documents recommend that indoor air sampling be conducted during the heating season (i.e., winter months) based on the assumption that negative building pressure will increase the magnitude of the vapor intrusion impact; however, building pressure can vary over short periods of time in response to changes in wind speed and direction, ambient temperature, and building operating conditions, thus requiring multiple indoor air sampling events to characterize the range of indoor air chlorinated VOC concentrations attributable to vapor intrusion. As an alternative, controlling building operating conditions to induce a continuous negative building pressure during a scheduled sampling event may be more effective to characterize the potential for vapor intrusion impacts. To evaluate the utility of induced building depressurization for the evaluation of vapor intrusion, a comprehensive sampling program was conducted at three residences overlying groundwater impacted by TCE. In each residence, at least three indoor air samples, three sub-slab gas samples, and one ambient air sample were collected for analysis of VOCs and radon under baseline building operating conditions and depressurization conditions. In addition, sulfur hexfluoride (SF6) was used to measure building air exchange rates throughout the sampling program, and cross-foundation pressure gradients were monitored using a differential pressure transducer. Following the collection of baseline samples, a negative building pressure was induced by use of a window box fan and conditions were allowed to stabilize for at least 12 hours prior to the collection of depressurization samples. For the three buildings studied, the indoor air concentration of chemicals associated with the subsurface (i.e., TCE and radon) changed little in response to building depressurization, ranging from 90 to 200% of baseline concentrations; however, building depressurization resulted in a 4- to 8-fold increase in building air exchange rates, indicating that the mass flux of these chemicals across the building foundation increased significantly to maintain the indoor air concentrations. In contrast to subsurface-associated chemicals, VOCs not detected in subsurface samples and believed to be associated with indoor sources (e.g., PCE, 1,2-DCA, and BTEX) decreased in concentration in indoor air samples by an average of 50%. In summary, compared to a typical sampling event, the use of building depressurization and tracer gases provided an improved understanding of the likely source of VOCs detected in indoor air and of the potential for vapor intrusion at the residences studied.

Experimental Monitoring of Cr(VI) Bio-Reduction Using Electrochemical Geophysics
Canan, B. (TDM Consulting, Boise, ID); G.R. Olhoeft (Colorado School of Mines, Golden); W.A. Smith (Idaho National Laboratory).
Journal of Environmental & Engineering Geophysics, Vol 12 No 3, p 255-266, 2007

Investigators explored the feasibility of applying complex resistivity to the detection and monitoring of microbially induced reduction of hexavalent chromium (Cr(VI)) to the less toxic Cr(III). The work involved defining in column experiments the minimum and maximum concentration of the chemical and biological compounds in contaminated samples for which the Cr(VI) to Cr(III) reduction processes could be detected via complex resistivity. The first experiment compared three concentrations of Cr(VI) at the same bacterial cell concentration. The second experiment established background samples with and without Cr(VI) and bacterial cells. The third experiment examined the influence of three different bacterial cell counts on the same concentration of Cr(VI). A polarization relaxation mechanism was observed between 10 and 50 Hz. The polarization mechanism, unfortunately, was not unique to bio-chemically active samples. Spectral analysis of complex resistivity data, however, showed that the frequency where the phase minimum occurred was not constant for bio-chemically active samples throughout the experiment. A significant shift in phase minima occurred between 10 to 20 Hz from the initiation to completion of Cr(VI) reduction. This phenomenon was quantified using the Cole-Cole model and the Marquardt-Levenberg nonlinear least square minimization method. The data suggest that the relaxation time and the time constant of this relaxation are the Cole-Cole parameters most sensitive to changes in biologically induced reduction of Cr(VI).

Fiber Optic Sensors For Detection of Toxic and Biological Threats
Mahmoud El-Sherif, Lalitkumar Bansal, and Jianming Yuan
Sensors, Vol 7 No 12, p 3100-3118, 2007

A novel class of fiber optic chemical sensors has been developed for detection of toxic and biological materials. The design of these fiber-optic sensors is based on a cladding modification approach. In a small section, the original passive cladding of the fiber was removed, and the fiber core was coated with a chemical-sensitive material. Any change in the optical properties of the modified cladding material resulting from the presence of a specific chemical vapor changes the transmission properties of the fiber and results in modal power redistribution in multimode fibers. Both total intensity and modal power distribution (MPD) measurements were used to detect the output power change through the sensing fibers. The MPD technique measures the power changes in the far field pattern, i.e., spatial intensity modulation in two dimensions. Conducting polymers, such as polyaniline and polypyrrole, have been reported to undergo a reversible change in conductivity upon exposure to chemical vapors. The conductivity change is accompanied by optical property change in the material. Polyaniline and polypyrrole were selected as the modified cladding material for the detection of hydrochloride, ammonia, hydrazine, and dimethyl-methylphosphonate (DMMP, a simulant for the nerve agent sarin), respectively. Several sensors were prepared and tested successfully. Dramatic improvement was observed in sensor sensitivity when the MPD method was applied. This paper presents an overview of the developed class of fiber-optic sensors and describes results achieved.
http://www.mdpi.net/sensors/list07.htm

Field-Portable and Automated Immunosensors for Hexavalent Uranium, Other Heavy Metals, and Chelators
Blake, Diane A., Haini Yu, Scott J. Melton, Nurettin Sahiner, and Robert Blake II
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 24, 2007

The goal of this project is to continue the development of new techniques for the rapid, automated identification of radionuclides, metals, and chelators that may contaminate surface and groundwater at DOE sites. A set of high-affinity, highly selective binding reagents (monoclonal antibodies) is being developed and refined to facilitate their use in two different immunosensors that can rapidly and accurately measure environmental contaminants in the field.

Sensor technologies already in place will be the foundation for the development of additional assays for metal, radionuclide, and chelator contaminants. The research objectives for this project and progress to date are as follows: (1) To successfully deploy present immunosensors at DOE sites, by adapting the immunoassay procedures to site-specific geochemistries. Design and construction of the new field-portable immunosensor has been completed, and sensor function has been characterized using commercially available anticaffeine antibodies and soluble caffeine. A novel hydrogel (prepared by copolymerization of N-vinyl 2-pyrrolidone/acrylonitrile and subsequent amidoximation) has been employed to specifically bind UO2 2+ in aqueous samples. Preliminary studies have shown that a 1 cubic cm piece of polymer will lower the UO2 2+ concentration from 1 ppm to below drinking water standards (30 ppb) in 100 mL of sample. We are devising a simple binding and elution strategy, based on a variation of this polymer, as a pretreatment strategy for the assay of surface and groundwater samples contaminated with UO2 2+. (2) To devise immunosensor-based assays for Pb(II), Hg(II), and/or Cr(III) in surface and/or groundwater. A bifunctional derivative of NOTA (1,4,7-triazacyclononane-1,4,7-triacetic acid) has been covalently attached to a carrier protein and loaded with Cr(III). This Cr(III)-chelate protein conjugate will be used as an immunogen for development of antibodies for Cr(III). Activities continue on the adaptation of an existing immunosensor-based assay for Pb(II) to environmental samples. (3) To develop new technologies in antibody engineering that will enhance the immunosensor project. One of the monoclonal antibody used in the uranium immunosensor, clone #12F6, has been expressed as a recombinant protein. Molecular modeling and subsequent site-directed mutagenesis of selected amino acid side chains in the binding site have led to a new protein that binds to uranium with ~50% higher affinity than the original antibody. A Fab fragment of the 12F6 monoclonal antibody has been crystallized; we hope to use these crystals to solve the 3-dimensional structure of the 12F6 antibody. Extensive binding studies of a second antibody that recognizes chelated UO2 2+ (clone #8A11) have revealed novel synergistic activity after covalent modification (R.C. Blake II et al. (2007) Biochemisty: 46,1573).

Field-Portable X-Ray Fluorescence (FP-XRF) Determinations of Metals in Post-Blast Ordnance Residues
Walsh, Marianne E.
ERDC/CRREL TR-04-5, 33 pp, Mar 2004

Field-portable X-ray fluorescence (FP-XRF) analyzers, such as the Niton 700, provide rapid, on-site analyses for a variety of elements. FP-XRF was used to determine metals in post-blast ordnance residue deposited on snow, which provided large collection surfaces free of soil particles. The ordnance included M67 hand grenades, 40-mm grenades, 60-mm and 81-mm mortar projectiles, 105-mm howitzer projectiles, claymore mines, and C4 demo blocks with M6 blasting caps. For most of these items, the post-blast residue contained lead, iron, copper, and zinc. FP-XRF also was used to determine these elements in soils from training ranges where the ordnance items were used. When present above the FP-XRF limits of detection, the FP-XRF determinations of lead, zinc, and copper did not differ significantly from determinations by laboratory analyses.
http://www.crrel.usace.army.mil/library/technicalreports/TR04-5.pdf

Field Screening Test Method for Fingerprinting Petroleum Hydrocarbon Sites
Greason, S., Sitelab Corporation, West Newbury, MA.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Field screening of soils and sediments for polyaromatic hydrocarbons (PAHs) has improved using on-site innovative technology, such as Sitelab's new UVF-3100D model. This portable UV fluorescence spectrometer has been widely used to test volatile and semi-volatile aromatic hydrocarbons for their gasoline and diesel range fractions. The instrument now can be used to help assess and clean up sites contaminated with benzo[a]pyrene and other carcinogenic PAHs commonly found in coal tars, coal ash, creosote, and weathered fuel oils. Optical filters have been developed recently that are more sensitive and selective to the target PAH compounds reported by EPA Method 8270 and performed by certified laboratories, a very time-consuming and expensive analysis. Samples are first extracted in methanol solvent using disposable test kits and then measured on the analyzer, which is calibrated to a standard containing 17 PAH compounds, the same compounds reported by the off-site GC/MS method. The equipment is easy to operate and quality controlled. From start to finish, results take 5 to 10 minutes. Correlation is very good. In addition, the new PAH optics have become an integral part of Sitelab's fluorescence fingerprinting method for hydrocarbon identification. The proportions of a sample's VPH, EPH, and target PAH fractions vary depending on the age and type of petroleum contamination. The signatures exhibited provide forensic information in the field within minutes, allowing environmental professionals to delineate contaminated sites more cost effectively. This presentation highlights several case studies where the technology has been used and discusses cost savings, test performance, and regulatory acceptance. [Note: A similar presentation from the 2006 Umass Conference is available on line.]
http://www.site-lab.com/Umass_SoilsConference_Oct2006.PDF

Flow Injection Technique for Biochemical Analysis with Chemiluminescence Detection in Acidic Media
Chen, Jing and Yanjun Fang.
Sensors, Vol 7 No 4, p 448-458, 2007

Chemiluminescence (CL) is the light emission derived from a chemical reaction in which chemically excited molecules decay to the electronic ground state and emit photons. In terms of the production mechanism of light emission, the CL technique can be divided into direct CL and indirect CL, in which the chemical energy is transferred from a product in an excited state to a fluorophore. Measurement of light from a chemical reaction is useful in chemical analysis because under appropriate experimental conditions the light intensity is directly related to the analyte concentration, allowing precise and sensitive quantitative analysis. Ninety references are reviewed to show the development over the last 10 years of acidic CL methods for biochemical analysis by use of flow injection. Proposed methods for biochemical analysis are described and compared according to the CL system used.
http://www.mdpi.net/sensors/list07.htm

Fluorescent Dyes Define Ground Water Flow Paths in Unconsolidated Aquifers
Hinchey, E. (ERM-Northeast, Inc., Syracuse, NY); M. Otz (ERM & NannoTrace Technologies).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Organic fluorescent dyes are rarely used in organic-rich environments because most dissolved organic substances fluoresce, which camouflages the fluorescent dyes. The authors report the results of the successful application of ultra-high resolution dye tracing experiments in unconsolidated aquifers at multiple sites affected with organic contaminants. Continuous synchronous spectrofluorometric scanning techniques have been developed to characterize background water that allows identification of the fluorescent fingerprint of groundwater affected by organic contaminants. Dyes are chosen with a specific spectral signature and dominant wavelength peak that does not overlap with the background fluorescence, allowing tracer detection in the part per trillion range. The combined background identification techniques and ultra-low detection limits provide a cost-effective and ground-truthed method of empirically determining actual subsurface flow paths. Results are presented from a site contaminated for over 50 years with chlorinated solvents, cutting oils, and heating fuel. Investigators injected low concentrations of fluorescent dyes (i.e., uranine and sulforhodamine B) in monitoring wells at opposite ends of the site to determine the direction and velocity of groundwater flow and to evaluate matrix effects to dye transport. Within 12 days, the uranine dye reached an on-site groundwater recovery system, identifying the major flow paths across the site. The observed velocity and flow differed significantly from multiple observations via groundwater gauging and aquifer testing. At a second site, ultra-low detection limits allowed dye tracing to be conducted close to potential sensitive receptors in a populated area. The dye tracer study successfully identified actual cross-gradient limits of groundwater flow, which will be used to direct the precise application of in situ oxidation chemicals. The fluorescent dye techniques developed provide a degree of accuracy to flow-path and aquifer analysis that previously was unavailable to investigators of contaminated ground water in unconsolidated formations.

Four-Wire Impedance Spectroscopy on Planar Zeolite/Chromium Oxide Based Hydrocarbon Gas Sensors
Hagen, G., A. Schulz, M. Knoerr, and R. Moos.
Sensors, Vol 7 No 11 p 2681-2692, 2007

Impedometric zeolite hydrocarbon sensors with a chromium oxide intermediate layer show promise with respect to sensitivity and selectivity. A special planar setup was designed that is very close to real sensor devices. It allows for conducting four-wire impedance spectroscopy as well as two-wire impedance spectroscopy. Using this setup, it was clearly demonstrated that the sensing effect can be ascribed to an electrode impedance. By combining two- and four-wire impedance measurements at one single frequency, the interference of the volume impedance can be suppressed and an easy signal evaluation is possible without taking impedance data at different frequencies.
http://www.mdpi.net/sensors/list07.htm

Fugitive Coke Oven Gas Emission Profile by Continuous Line Averaged Open-Path Fourier Transform Infrared Monitoring
Lin, Chitsan and Naiwei Liou, Department of Marine Environmental Engineering, National Kaohsiung Marine University, Kaohsiung, Taiwan, Republic of China, Pao-Erh Chang and Jen-Chin Yang, Energy and Environment Research Laboratory, Safety and Health Technology Division, Taiwan Industrial Technology Research Institute, Taiwan, Republic of China, Endy Sun, Environmental Science Corporation, Taipei, Taiwan, Republic of China
Journal of the Air and Waste Management Association, Vol 57 No 4, April 2007

There has been little research done on the coke oven gas emissions of volatile organic compounds. This study monitored coke oven gas emissions over 16.5 hours at a site in southern Taiwan using an open-path Fourier transform infrared (OP-FTIR) system. Results suggested that, because the type of pollutants emitted differed over time, different emission sources were involved at different times over the study period. Furthermore, the study shows that data collected using this system can be used to characterize differences in the location of sources, making it easier and more cost effective to identify and control VOC emissions and improve human health.

Gas Sensors Based on Conducting Polymers
Bai, H. and Gaoquan Shi.
Sensors, Vol 7 No 3, p 267-307, 2007

The authors review gas sensors fabricated based on conducting polymers, such as polyaniline (PAni), polypyrrole (PPy), and poly(3,4-ethylenedioxythiophene) (PEDOT), as the active layers. This review covers the sensing mechanism and configurations of the sensors and the factors that affect sensor performance. The disadvantages of the sensors and future prospects in this field also are discussed.
http://www.mdpi.net/sensors/list07.htm

GCxGC-TOFMS of Chlorinated Dioxins and Furans in Environmental Samples
Cochran, J., J.-F. Focant, A. Sjoedin, D. Patterson, Jr., E. Reiner, K. MacPherson, T. Kolic, F. Dorman, and S. Reese.
Dioxin 2004: 24th International Symposium on Halogenated Persistent Organic Pollutants, Organohalogen Compounds, Vol 66, p 846-851, 2004

U.S. EPA methods 1613 and 8290A specify HRGC-HRMS (with selected ion recording) to meet the sensitivity and selectivity necessary for dioxin analysis. One of the challenges is not only to separate the dioxins and furans from other interferences (either through chromatography or HRMS) that can exist at higher concentration levels, but also to separate the most toxic congeners from each other within their respective homolog groups. For individual quantification of isomers, chromatographic separation is mandatory. An alternate way to approach the dioxin and furan separation problem is to use comprehensive 2-D GC (GCxGC). GCxGC increases peak capacity by applying two independent separations to a sample in one analysis. Typically, GCxGC involves press-fitted serial columns (differing phases) separated by a thermal modulator. One separation is performed on the first column, and its effluent is continually focused and "injected" onto the second column, where another separation occurs. By keeping the second column short a series of high-speed chromatograms are generated, and the first column

separation is maintained. Separation results are plotted as a retention plane (column 1 time x column 2 time), which is also known as a contour plot. The focusing process of GCxGC leads to peaks on the order of 50 to 500 ms wide, so a fast detector is required. When MS is used, only time-of-flight (TOF) has the necessary acquisition rates (hundreds of spectra/sec). Even though a fast TOF is a low resolution MS, the separating power of GCxGC gives the potential to provide selectivity for dioxin and furan analysis. The focusing effect of GCxGC enhances sensitivity, so that sub- to low-pg levels can be determined. This work describes preliminary results obtained using GCxGC-TOFMS with isotope dilution quantification for the determination of chlorinated dioxins and furans in a variety of environmental and biological matrices.
http://dioxin2004.abstract-management.de/pdf/p629.pdf

Generating the Right PCB Data Determination of Aroclors Versus PCB Congeners
Narquis, C.T. (Fluor Government Group); J.E. Hyatt and A.L. Prignano (Fluor Hanford. Inc.).
HNF-34789-FP, 13 pp, Nov 2007 [to be presented at Waste Management 2008]

Polychlorinated biphenyls, or PCBs, is a comprehensive term used to identify a group of 209 individual compounds known as congeners. PCBs were originally produced in the United States as specific mixtures of congeners known as Aroclors. PCBs can be analyzed and quantified either as Aroclor mixtures or as individual congeners. Aroclor analysis, which is the more common analytical method applied to PCBs, has been in use for decades. In general, most cleanup regulations pertaining to PCBs are based on total PCB concentrations using Aroclor analyses. Congener analysis is relatively new to environmental cleanup and restoration due to both technical issues and associated cost. The benefits of congener analysis are that it allows a more direct analysis of the risk of the PCBs. The World Health Organization (WHO) has identified twelve specific congeners as dioxin-like with toxicity ranging from 0.00003 to 0.1 times the standard 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) toxicity. This paper defines Aroclors and congeners and compares the current application and usefulness of the two analytical methods for environmental restoration and cleanup. A strategy for the best use of the two methods to optimize overall characterization cost is presented. As part of the strategy. a method using the data from Aroclor analyses to calculate 2,3,7,8-TCDD toxicity equivalent concentrations is also presented.
http://www.osti.gov/bridge/product.biblio.jsp?query_id=1&page=0&osti_id=920178

GeoChip: Development and Applications for Microbial Community Analysis
He1, Zhili, Ye Deng, Joy Van Nostrand, Christopher Hemme, Terry Gentry, Weimin Wu, Christopher Schadt, Liyou Wu1, Baohua Gu, David Watson, Terry C. Hazen, Phil Jardine, Craig Criddle, and Jizhong Zhou
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 96, 2007

Microarray technology provides the opportunity to identify thousands of microbial genes or populations simultaneously. Recently, a comprehensive functional gene array, called GeoChip, has been developed, evaluated, and applied for characterizing microbial communities in natural systems. GeoChip 2.0 contains 24,243 oligonucleotide (50mer) probes and covers >10,000 genes in >150 functional groups involved in nitrogen, carbon, sulfur, and phosphorus cycling, metal reduction and resistance, and organic contaminant degradation. It is a powerful generic tool and can be used for: (1) profiling various environmental samples, such as soil, groundwater, sediments, oil fields, deep sea, animal guts, etc; (2) studying biogeochemical processes and functional activities of microbial communities important to human health, agriculture, energy, global climate change, ecosystem management, and environmental cleanup and restoration; (3) exploring direct linkages of microbial genes/populations to ecosystem processes and functions; and (4) detecting functional genes and/or organisms in a particular environment. Here, we present two application examples on the dynamics and stability of microbial genes and associated communities during a bioremediation period at the ERSD Field Research Center (FRC) at Oak Ridge and the Hanford site. GeoChip 2.0 was first used to track the dynamics of metal-reducing bacteria and associated communities for an in situ bioremediation at the FRC site. Samples were taken from different wells after ethanol injections (after Day 166). During the uranium reduction period, both FeRB and sulfur-reducing bacteria (SRB) populations reached their highest levels at Day 212, followed by a gradual decrease over 500 days. Consequently, the uranium in groundwater and sediments was reduced, and the uranium concentrations in the groundwater were significantly correlated with the total abundance of c-type cytochrome genes from Geobacter-type FeRB and Desulfovibrio-type SRB. Mantel tests also indicated that there was significant correlation between the differences of uranium concentrations and those of total c-cytochrome gene abundance or dsrAB gene abundance. These results suggested that Geobacter-type FeRB and SRB played significant roles in reducing uranium to a level below the drinking standard (<30 µg/L). GeoChip 2.0 was also used to evaluate functional communities at a lactate-fed chromium reduction system at the Hanford site. Extraction well samples showed higher numbers of functional genes than the injection well at the same depth. Within the extraction well, abundance decreased with depth. However, the relative abundance of chromium resistant genes increased with depth in this same well. All results demonstrate that GeoChip is a useful tool for analysis of microbial communities in natural systems. GeoChip 2.0 is the most comprehensive functional gene array currently available for environmental studies, but because of exponential increases in the number of genes and sequences for each gene, a new generation of this array (GeoChip 3.0) is in development. GeoChip 3.0 is expected to have the following new features: (1) it is more comprehensive and representative, and covers >37,700 gene sequences of 290 gene families, including the phylogenetic marker, gyrB; (2) the homology of automatically retrieved sequences by key words is verified by HUMMER, using seed sequences so that unrelated sequences are removed; (3) a software package (including databases) has been developed for sequence retrieval, probe and array design, probe verification, array construction, array data analysis, information storage, and automatic update, greatly facilitating management of such a complicated array, especially for future updates; and (4) it includes GeoChip 2.0 probes, and those probes are checked against with new databases.

Guided-Wave Optical Biosensors
Passaro, V.M.N., F. Dell'Olio, B. Casamassima, and F. De Leonardis.
Sensors, Vol 7 No 4, p 508-536, 2007

This review of guided-wave optical biosensors covers advantages related to optical technologies, a discussion of integrated architectures, the main classes of bio receptors, the most attractive optical transduction mechanisms, and the possibility of using Mach-Zehnder and Young interferometers, microdisk and microring resonators, surface plasmon resonance, hollow

and antiresonant waveguides, and Bragg gratings to realize very sensitive, selective, ultra-compact, and fast biosensors. CMOS-compatible technologies have proved to be most attractive for fabrication of guided-wave photonic biosensors.
http://www.mdpi.net/sensors/list07.htm

High Resolution Resistivity Imaging of Fluid Injections
Bell, R.S.
Geological Society of America Abstracts with Programs, Vol 39 No 6, p 520, Paper 193-4, 2007

The ability of earth materials to conduct electricity will vary, often significantly, as a result of the injection of fluid. This volumetric variation in resistivity with respect to time can be observed in time-sequenced images of the wetting front as it advances through a rock pile or into a geologic formation. In some instances, the hydraulic conductivity can be derived directly from the time series electrical data. The high-resolution resistivity method has been adapted successfully to the monitoring of a surfactant flood experiment in an oil field, as well as to a high-pressure injection of a lixiviant into a gold heap leach stack.

Home-made Detection Device for a Mixture of Ethanol and Acetone
Reungchaiwat, A., T. Wongchanapiboon, S. Liawruangrath, and S. Phanichphant.
Sensors, Vol 7 No 2, p 202-213, 2007

The commercially available TGS 822 sensor head from Figaro Company Ltd. was selected for the detection of ethanol and acetone. Because the TGS 822 cannot be used by itself for the detection of a mixture of acetone and ethanol, an analytical column was added to the detection system to separate ethanol and acetone before they reached the sensor head. The response data can be collected by a software program on a PC. The optimum conditions of the system for the detection of acetone and ethanol were achieved by varying the flow rate of the carrier gas, VH, VC, RL, and the injection port temperature. The best flow rate of the carrier gas was 15 mL/min, with circuit settings of VH = 5.5 V, VC = 20 V, RL = 68 k omega and an injection port temperature of 150 degrees C. The oxide semiconductor sensor detection principle is based on the chemical adsorption and desorption of gas on the sensor surface. Under normal atmospheric condition, the types of chemisorbed oxygen ion on the surface of the oxide semiconductor are O2- , O-, and O2-. The type of chemisorbed oxygen ion on the SnO2 surface is found to be O-. The change in density of the oxygen-negative ion on the SnO2 surface is used to determine the amount of ethanol and acetone quantitatively, while the retention times (tR) of ethanol and acetone were 1.95 and 0.57 min, respectively. The limits of detection were 9.27 mg/L for ethanol and 4.41 mg/L for acetone.
http://www.mdpi.net/sensors/list07.htm

Horseradish Peroxidase (HRP) Immobilized Poly(aniline-co-m-aminophenol) Film Electrodes: Fabrication and Evaluation as Hydrogen Peroxide Sensor
Seo, K.-D., K.-P. Lee, A.I. Gopalan, S.J. Chung, Y.T. Lim, and S.-H. Choi.
Sensors, Vol 7 No 5, p 719-729, 2007

Enzyme-modified electrodes were fabricated with polyaniline (PANI) and a PANI derivative by physical entrapment of horseradish peroxidase (HRP) and covalent immobilization

of HRP. The polymer films contained gold nanoparticles, and HRP was immobilized in fabricating one set of electrodes. In the other set of electrodes, HRP was immobilized into polymer films through covalent functionalization using a cross-linker. The four enzyme electrodes were tested for electrocatalytic activities toward hydrogen peroxide (H2O2). The results reveal that the enzyme electrode with physical entrapment of HRP exhibits pronounced electrocatalysis towards H2O2 over the other electrodes. This study provides the basis of fabricating enzyme electrodes for sensing H2O2. The enzyme must be entrapped in the film electrode without involving any chemical functionalization to give a pronounced electrochemical response to H2O2.
http://www.mdpi.net/sensors/list07.htm

A Hydrogen Peroxide Sensor Prepared by Electropolymerization of Pyrrole Based on Screen-Printed Carbon Paste Electrodes
Li, G., Y. Wang, and H. Xu.
Sensors, Vol 7 No 3, p 239-250, 2007

A disposable amperometric biosensor was developed for commercial use in detection of hydrogen peroxide. The sensor is based on screen-printed carbon-paste electrodes modified by electropolymerization of pyrrole with entrapped horseradish peroxidase. The techniques of fabricating the enzyme electrodes are suitable for mass production and quality control. The biosensor shows a linear amperometric response to H2O2 from 0.1 to 2.0 mM, with a sensitivity of 33.24 uA/mM/sq cm. Different operational parameters of electropolymerization are evaluated and optimized.
http://www.mdpi.net/sensors/list07.htm

Improvement of Bioactive Compound Classification Through Integration of Orthogonal Cell-Based Biosensing Methods
Chaplen, F.W.R., G. Vissvesvaran, E.C. Henry, and G.N. Jovanovic.
Sensors, Vol 7 No 1, p 38-51, 2007

Lack of specificity for different classes of chemical and biological agents, as well as false positives and negatives, can limit the range of applications for cell-based biosensors. The authors suggest that the integration of results from algal cells (Mesotaenium caldariorum) and fish chromatophores (Betta splendens) improves classification efficiency and detection reliability. The two detection systems were investigated independently for classification of the toxin set by performing discriminant analysis on cells challenged with paraquat, mercuric chloride, sodium arsenite, and clonidine. The algal system correctly classified 72% of the bioactive compounds, while the fish chromatophore system correctly classified 68%. Their combined classification efficiency was 95%. The algal sensor readout is based on fluorescence measurements of changes in the energy-producing pathways of photosynthetic cells, whereas the response from fish chromatophores was quantified using optical density. Change in optical density reflects interference with the functioning of cellular signal transduction networks. Thus, algal cells and fish chromatophores respond to the challenge agents through mechanisms of action sufficiently different to be considered orthogonal.
http://www.mdpi.net/sensors/list07.htm

Incorporating Engineered Controls into Vapor Intrusion Evaluations
Day, A.G. and W. Carson, LFR, Inc., Emeryville, CA.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

To assess potential human health risk associated with residential redevelopment at brownfield sites, evaluations were performed to estimate indoor air concentrations inside hypothetical buildings. The results of the evaluations were used as a risk management tool to assess whether vapor controls would be a necessary part of the property redevelopments. Soil gas or groundwater data provided the source concentration for the Johnson & Ettinger vapor transport model. Each identified volatile organic compounds detected in the subsurface was considered. If the results of the modeling indicated that the estimated cancer risk would be above the California regulatory target of 10(-6), then the model was modified by consideration of the influence of engineered controls (e.g., vapor barriers, open podium garages, and subterranean garages). Modeling parameters were adjusted to replicate the influence of the chosen engineered control on vapor intrusion. Where appropriate, the result of the modeling evaluations has been incorporated into the building design as a risk mitigation measure.

Influence of Dissolved Oxygen Convection on Well Sampling
Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery.
Ground Water Monitoring and Remediation, Vol 27 No 3, p 49-58, 2007

Transport of dissolved oxygen to the screened interval of a well can have an adverse effect on the ability of passive samplers to produce accurate concentrations of oxygen-sensitive solutes, such as iron, other redox indicators, and microbiological data. A comparison of passive sampling to low-flow sampling in a well undergoing convection, however, showed general agreement of VOC concentrations. During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can increase equilibration times substantially, cause false stabilization of indicator parameters, give false indications of the redox state, and provide microbiological data that are not representative of the aquifer conditions. Data from this investigation show that simple in-well devices can mitigate convective transport of oxygen effectively. The devices can range from inflatable packers to simple, inexpensive baffle systems.

Innovative Groundwater Imaging Technology
Kluger, M., Dajak, LLC, Wilmington, DE.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Traditional methods for determining the potential flow paths of subsurface pollution require extensive drilling, a time-consuming and expensive process that could cause formation caving or slumping in loose sands. The electromagnetic imaging procedure detailed in this presentation provides exceptionally accurate groundwater maps with significantly less drilling and thus lower costs in terms of time, money, and ecological disruption. In this rapid and minimally invasive technique, electrodes are used to charge the groundwater in question with a low-voltage, low-amperage, high-frequency electrical current. As the current moves through the water between the electrodes, it induces a magnetic field whose size, shape, magnitude, and direction are characteristic of the surrounding aqueous system. This field is then read at the surface by a specially tuned receiver. The data generated can be used to create maps indicating the attributes of the subsurface water network, including potential flow paths. This presentation discusses the science behind the methodology and lessons learned from recent applications.

In Situ Measurements of Labile Al and Mn in Acid Mine Drainage Using Diffusive Gradients in Thin Films
Sndergaard, Jens, Univ. of Copenhagen, Copenhagen. Denmark.
Analytical Chemistry, Vol 79 No 16, p 6419-6423, 2007

This paper reports on the results of an experiment to determine if the technique of diffusive gradients in thin films (DGT) can be used for acid mine drainage (AMD). Generally low pH will reduce the ability of the DGT to adsorb metals. DGT measurements were performed in the laboratory and in situ in the field on labile Al and Mn in AMD (pH 3.1-4.2). The results indicate that DGT can be used in water with pH as low as 3.0 for Al and 4.0 for Mn without correcting for reduced adsorption. The is a linear decrease in the adsorption of Mn with pH below 4.0 that can be corrected for. Taking this correction into account the author found that 84-100% of the total dissolved Al and Mn measured in the field was DGT-labile. The author concludes that the use of DGT can be extended below the previously reported pH working range for Al, and for Mn and the technique can be applied at AMD sites.

Integrated Ground-Water Monitoring Strategy for NRC-Licensed Facilities and Sites: Logic, Strategic Approach and Discussion
Price, V., T. Temples, J. Tauxe, R. Hodges, and R. Falta, Advanced Environmental Solutions, LLC, Lexington, SC.
NUREG/CR-6948, Vol 1, 134 pp, Nov 2007

This document presents a logical framework for assessing what, how, where, and when to monitor underground water to ensure that a licensed nuclear site or facility is behaving within the expected limits as described by the performance assessment. The integrated ground-water monitoring strategy is implemented as an iterative process beginning with analysis of any existing site and facility characterization and monitoring data, any existing conceptual site model (CSM), which generally is a hydrogeologic model, and any existing risk assessment or performance assessment model. The iterative nature of the strategy results in a graded approach to development or evaluation of a monitoring program. Through analysis, an initial assessment of what, how, when, and where to monitor to evaluate system performance is made. Performance indicators include chemicals, hydrogeologic attributes, and other features, events, or processes that may influence contaminant flow and transport significantly. These performance indicators may be directly measurable in a monitoring program or may be derived from compilations and interpretations of data. Implementation of the integrated strategy provides the following benefits: (1) characterization allows development of CSM; (2) CSM allows modeling/simulation; (3) modeling allows prediction; (4) monitoring allows refinement; and (5) refinement allows confidence.
http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6948/v1/index.html

Integrated Ground-Water Monitoring Strategy for NRC-Licensed Facilities and Sites: Case Study Applications
Price, V., T. Temples, R. Hodges, Z. Dai, D. Watkins, and J. Imrich, Advanced Environmental Solutions, LLC, Lexington, SC.
NUREG/CR-6948, Vol 2, 231 pp, Nov 2007

This document discusses results of applying the integrated ground-water monitoring strategy to actual waste sites using existing field characterization and monitoring data. Application of such a systematic approach to dealing with complex sites will reduce uncertainty associated with site analysis and the uncertainty associated with management decisions about a site. The strategy can be used to guide the development of a ground-water monitoring program or to review an existing one. The sites selected for study fall within a wide range of geologic and climatic settings, waste compositions, and site design characteristics and represent realistic cases. No one case study illustrates a comprehensive application of the strategy using all available site data. Instead, each case study focuses on certain aspects of the strategy to illustrate concepts that can be applied generically to all sites. The following test sites were selected for case study: Charleston, South Carolina, Naval Weapons Station; Brookhaven National Laboratory on Long Island, New York; the USGS Amargosa Desert Research Site in Nevada; Rocky Flats in Colorado; C-Area at the Savannah River Site in South Carolina; and the Hanford 300 Area. The report includes a section that provides examples of detailed analysis of monitoring data.
http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6948/v2/index.html

Integrated Nucleic Acid System for In-Field Monitoring of Microbial Community Dynamics and Metabolic Activity
Chandler, Darrell P. and Eric Roden
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 29, 2007

With the accelerated development and use of nucleic acid microarray technology, there is considerable interest in applying existing (off-the-shelf) microarray methods and devices in uncharacterized sample backgrounds. Uncharacterized sample backgrounds create both a sample-preparation and data interpolation challenge for the practical use of microarrays. The sample-preparation challenge results from the co-extraction of soluble environmental constituents that interfere with molecular techniques (including polymerase chain reaction [PCR] amplification, hybridization, and fluorescent detection) and the preponderance of unknown and uncharacterized nontarget organisms in the biological background. The data interpolation challenge is that theoretical and experimental data show that mismatched targets preferentially bind to microarray probes under nonequilibrium hybridization conditions, exacerbating the problem of false positive detection. Depending upon the nucleic acid purification and labeling strategy, nontarget sequences can also contribute to increased local and global background, degrading overall system (sample-to-answer) performance and dynamic range. One strategy to address cross-hybridization is to remove unpredictable probes from the array. Another is to increase the total number of probes on an array and statistically compare the signal intensity between perfectly matched (PM) and single-base-mismatched (MM) duplexes. A third approach is to generate post hybridization thermal dissociation curves for every probe on the array. By themselves, however, these techniques do little to address the (fluidic or automated) nucleic acid sample preparation challenge or simplify the attendant analytical process or instrumentation. Based on our prior work with oligonucleotide- coated particles as automated affinity purification matrices, we reasoned that multiplexed affinity purification and thermal dissociation prior to biochip hybridization would simplify uncharacterized sample admixtures, thereby minimizing or eliminating sample interferents, improving hybridization specificity on a microarray detector, and minimizing or eliminating the need for post hybridization thermal dissociation analysis. Effort in FY06 therefore focused on developing an integrated thermo-affinity sample preparation subcircuit for sample purification and enrichment that is consistent with a field-portable form factor and analytical processes, and evaluate the efficacy of thermo-affinity sample preparation on model admixtures of varying complexity. Femtomole quantities of oligononucleotide and synthetic gene targets were effectively enriched from sample admixtures at a ratio of 1 target to 10,000 nontarget molecules. The extent and incidence of false positive hybridization and average signal:noise ratios for nontarget microarray probes was significantly improved after multiplexed thermo-affinity sample purification. The proof-of-principle results and thermo-affinity approach provide a new, relatively simple method for incorporating nucleic acid sample preparation into microfluidic structures and analysis systems. We will also present proof-of-principle results for incorporating Dr. Yi Lu's Pb and U DNAzymes into a field-portable microarray format.

Integrated Wireless Sensors in Oil Pipeline Integrity Monitoring
Umeadi, B.B.N. and K.G. Jones, Univ. of Greenwich, London, UK.
14th Annual International Petroleum Environmental Conference, 6-9 November 2007, Houston, Texas. Abstract only, 2007

A continuous, low-cost monitoring solution that can provide early warning of imminent failure is needed for pipelines. The authors discuss the findings of a laboratory-based test program to evaluate the potential for vibration sound emission detection to form the basis of an early warning system. Attenuation and waveform analysis were used to identify theoretical changes in the flow characteristics of a liquid medium as it passed along a damaged section of pipe. The effectiveness of piezoelectric sensors to detect the changed flow characteristics were evaluated for a range of artificially induced defects. The flow characteristics were analyzed using spectrum analysis of the signal across frequency bands and compared to the theoretical predictions. The results show that a piezoelectric vibration sound emission sensor can detect changes in the flow characteristics of water and diesel oil to a level of accuracy that could form the basis of an integrated wireless sensor device and the qualitative diagnosis theory the basis of an algorithm that could be used to associate the changed flow characteristics with the underlying pipeline defect without third-party intervention.

Investigating Ultrasonic Diffraction Grating Spectroscopy and Reflection Techniques for Characterizing Slurry Properties
Greenwood, Margaret S., Pacific Northwest National Laboratory, Richland, WA.
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 45, 2007

Our objectives in this work are to: (1) investigate the new technique of ultrasonic diffraction grating spectroscopy (UDGS) for the measurement of particle size and to develop a method for measurement online and in real time; and (2) investigate the reflection of an ultrasonic shear wave for the measurement of viscosity for on-line real-time measurement. In recent results, the ultrasonic beam produced by the “send” transducer travels through the solid and strikes the back of the grating, with the front of the grating in contact with the slurry. The angle of the transmitted beam increases as the frequency of the beam decreases. The frequency at which it reaches 90° is called the critical frequency. Slightly below the critical frequency, the existence of a transmitted beam is not possible, and the energy is transferred to other beams, such as that reflected to the “receive” transducer, where the signal shows a peak at the critical frequency. During this transition at the critical frequency, the ultrasound interacts with particles in the slurry. The peak in the receive transducer monitors this interaction, and the peak height varies according to the particle size. Data have been compared with two theoretical models: an inertial model and a scattering model. Results have been published (Ultrasonics 44 [2006] 1385–1393), and a manuscript describing nine diameters of polystyrene spheres for transmitted spectral orders m = 1 and m = 2 is ready to be submitted for publication. Some important results that will be presented: (1) Measurement of two peaks yields the particle size and the concentration of the slurry. (2) The velocity of sound in the slurry is determined from the critical frequency. (3) A peak height calibration can be used for determining the weight percent solids in a slurry. (4) The data for some particle sizes compare well with the inertial model, and other sizes with the scattering model. Thus, the inertial model can be investigated without the observation of scattering. Such studies can probe the basic interaction of ultrasound with particles and lead to a greater understanding of attenuation measurements. (5) Results using solutions of differing viscosity and the possibility of a sensor will be presented. (6) The research for viscosity measurements has been published in Ultrasonics (44, 2006). Future work includes research with gratings having critical frequencies of 13 MHz and 20 MHz, investigation of a new method for increasing particle size sensitivity, and using glass spheres for particles in addition to polystyrene spheres.

- Fluorescence offers a means of dramatically increasing the sensitivity of the spectroelectrochemical sensor, and we have demonstrated a limit of detection (< 10-12 M) that is 100 times lower than that needed for pertechnetate.
- TcO4 − preconcentrates in sensor films containing anion exchange polymers and can be electrochemically reduced. This is the first step in operation of a spectroelectrochemical sensor for TcO4 −.
- Prepared lower oxidation-state Tc-complexes fluoresce at ambient temperatures in sensor films, and these complexes exhibit reversible redox processes leading to fluorescence modulation, which is the second step in operation of a spectroelectrochemical sensor.
- The spectroelectrochemical sensor and associated instrumentation for either absorbance or fluorescence modes are portable and easily transported to and used at DOE sites.

Our continued work incorporates three specific tasks: Task 1, Refinement of the chemically selective reagent-containing sensor film for TcO4 - sensing Task 2, Development of the TcO4 - reductive trapping mechanism Task 3, Development and evaluation of prototype sensors. Tasks 1 and 2 will pave the way for development of prototype sensors and associated instrumentation. These will be used to evaluate and improve critical performance characteristics, such as limit of detection, range, response time, and reversibility. Optimized prototypes will be used to demonstrate sensor performance on TcO4 standards and samples from the vadose zone and subsurface water at the Hanford Site.

Ion-Selective Electrodes as Simple and Inexpensive Detectors for Soil Analysis
Radu, T., A. Radu, C. McGraw, and D. Diamond.
CEST2007: Proceedings of the 10th International Conference on Environmental Science & Technology, 5-7 September 2007, Kos Island, Greece. p A-1229-1236, 2007

The problem of heavy metal contamination arising from abandoned mining operations such as at Silvermines, Ireland, represents a challenge in terms of monitoring the extent of contamination in the surrounding area. Ion-selective electrodes (ISEs) are very sensitive and inexpensive analytical tools that can be applied to the determination of heavy metals that were until recently thought to be inappropriate for many environmental applications due to relatively high limits of detection. In this work, we examine the possibility of using ISEs for monitoring heavy metals in the environment using approaches that offer improved limits of detection. A more environmentally friendly method for extracting heavy metals from soil samples based on dilute nitric acid is also evaluated. The ISEs used were Pb2+-selective solid-contact electrodes with polypyrrole as the inner contact. As the existence of an inner water layer between the ion-selective membrane and the solid support can significantly affect the electrode response and detection limit, electrodes were first tested for the presence of a water layer. A water layer was observed in electrodes having ion selective membrane deposited directly to the solid support (i.e. no conductive polymer as inner layer). The presence of polypyrrole as an inner layer resulted in negative water layer test. Only electrodes that tested negative for this water layer were used for measurement of Pb concentrations. In calibration experiments, the electrodes showed a detection limit of 1.2x10-6 M (0.25ppm). The ISEs were used to measure the concentration of lead in digested field samples, and the results were compared with a reference method (AAS). The average percent of recovery for the ISEs when compared to AAS was 65% which is to a large extent due to differences in the fundamental response characteristics of the two methods, as ISEs only detect the free metal, whereas AAS detects total concentration. A good correlation between the two methods was observed which suggests that ISEs could be used for in-situ direct measurements.
http://www.srcosmos.gr/srcosmos/generic_pagelet.aspx?pagelet=Article%20summary&pub_id=9817

Laser-Induced Fluorescence for the Delineation & Characterization of Fuel-Contaminated Soils in Subarctic Climates
Andraschko, K.R. and C.S. Peyton, U.S. Army Corps of Engineers, Elmendorf AFB, AK.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

A key factor in successfully designing a remedial approach for fuel-contaminated sites is an accurate estimate of the nature, quantity, and location of contaminated soil. Standard sampling techniques often lead to large errors, extended field work, and cost overruns. These problems are magnified in Alaska and other cold regions where short work seasons and difficult logistics are common. Using a real-time, in situ laser-induced fluorescence (LIF) technique, the Corps of Engineers has been able to delineate fuel-contaminated soils with great accuracy in and above the saturated zones. The technology also can differentiate between contaminant types, such as gasoline, diesel, or bunker fuel oil. Subsequent remedial actions can then be designed and bid more accurately, saving time and money. Case studies are presented of projects in which LIF was used to address soil excavation, in situ treatment, or potentially responsible party issues.

Lead in Soil by Field Portable X-Ray Fluorescence Spectrometry: An Examination of Paired In-Situ and Laboratory ICP-AES Results
Binstock, D.A., W.F. Gutknecht, and A.C. McWilliams, RTI International, RTP, NC.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

A study was conducted to compare the performance of field-portable X-ray fluorescence (FPXRF) with lab-based ICP-AES. The study was designed to produce paired ICP-FPXRF measurements from soil samples collected at multiple locations within each of 9 geographically remote study sites. Soil samples tested in the field by FPXRF were returned to the laboratory for confirmatory lead analysis by ICP-AES. Evaluation of study data revealed that ICP-AES soil lead measurements were higher systematically than the paired FPXRF measurements. The degree of correspondence between ICP-AES and FPXRF measurements on the same soil sample is a function of a variety of factors, including soil moisture and particle size, that are specific to a particular location or site. To minimize the differences between field and laboratory results, a new protocol has been developed for field-drying and sieving collected samples and measuring them by FPXRF. To evaluate this protocol, composite samples were collected following both the HUD Guideline and ASTM protocols, measured following drying by FPXRF, and returned to the laboratory for confirmatory ICP-AES analysis. Evaluation of study data from several diverse sites revealed no statistical difference between paired FPXRF and ICP measurements following the new method. A simple, cost-effective in situ soil lead measurement is now available.

Lessons Learned on the Implementation of CRREL Multi-Increment Sampling (MIS) and Analysis by SW-846 Method 8330B
Koenig, M.R. (USACE, New England District, Concord, MA); L. Ekes (Environmental Chemical Corporation, Otis ANGB, MA); B. Chrigwin (STL-Burlington, VT); A. Hewitt, T.F. Jenkins, and M. Walsh (US Army Engineer Research and Development Center, CRREL, Hanover, NH).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

A multi-increment sampling (MIS) approach and modified analytical method 8330B (U.S. EPA) have been recommended for sampling and analysis of explosive compounds by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL). This method was recently adopted by EPA in its Small Arms Range (SAR) Work Plans. The MIS and Method 8330B have been implemented at small arms ranges and gun and mortar firing positions and target locations at the Massachusetts Military Reservation (MMR), Camp Edwards, MA. The MIS approach has been applied mainly to explosives. This presentation discusses several different MIS and grinding techniques that were evaluated at MMR. Specific MMR project requirements were developed based on the required MMR Program DQOs. These DQOs included dual-column confirmation using the phenyl hexyl confirmatory column with an extended target analyte list that includes NG, PETN, 2,4-DANT, 2,6-DANT, picric acid, and the RDX degradation by products MNX, DNX, and TNX. All 22 target explosives and propellants have been resolved in one analytical run on both the primary C-18 and confirmatory phenyl hexyl analytical HPLC columns. STL-VT has been analyzed using a photo diode array detector or UV spectral detection method for an additional level of confirmation. The closest matching concentration standard PDA spectra are compared to the sample PDA UV spectra for any dual-column confirmed explosive target analyte HPLC peak. The main focus on this presentation is on the lessons learned during the implementation of the CRREL MIS approach and analysis by SW-846 Method 8330B. The analytical method developments used to meet the MMR project-specific DQOs are discussed in detail, and successes are highlighted by review of actual SAR sampling and analysis data. The pros and cons encountered are evaluated throughout the presentation.

Long-Term Groundwater Monitoring Optimization: Clare Water Supply Superfund Site, Stageright Area, Clare, Michigan
U.S. EPA, Office of Solid Waste and Emergency Response.
EPA 542-R-07-009, 112 pp, Aug 2007

The current monitoring network for the StageRight (former Welltronics) Facility area near the Clare Public Water Supply was evaluated using a formal qualitative approach and statistical tools found in the Monitoring and Remediation Optimization System (MAROS) software. Using analytical and hydrogeologic data from sampling events conducted between June 1988 and May 2006, the network evaluation was conducted in September 2006 prior to activation of a new municipal well. The goal of the ground-water monitoring program is to track changes in concentrations of priority chlorinated constituents (vinyl chloride, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene) that may affect the drinking water remediation system used to treat the public water supply. Results from the qualitative evaluation and the MAROS well sampling frequency tool (the modified CES method) were used to develop a sample frequency strategy for ground water using conservative assumptions. An overall sample schedule was developed after considering site hydrogeology, the location of each well in relation to the plume and the water supply wells, individual well trends, non-detect values, and recent sample frequency.
http://www.epa.gov/tio/download/remed/hyopt/application/stagerightltmo_final_report.pdf

Long-Term Groundwater Monitoring Optimization: Clare Water Supply Superfund Site Permeable Reactive Barrier and Soil Remedy Areas, Clare, Michigan
U.S. EPA, Office of Solid Waste and Emergency Response.
EPA 542-R-07-010, 174 pp, Aug 2007

The current long-term ground-water monitoring networks for the permeable reactive barrier (PRB) and soil remedy areas at the Clare Water Supply Superfund Site were evaluated using a formal qualitative approach and statistical tools found in the Monitoring and Remediation Optimization System (MAROS) software. The PRB remedy consists of two PRBs in sequence installed to a depth of 17 feet below ground surface along the property boundary of the former Mitchell source area. Installed in December 2004, the PRBs are designed to treat

shallow ground water contaminated with chlorinated organic compounds (i.e., vinyl chloride, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene) as it migrates through the treatment walls. The walls reportedly are filled with iron-encrusted foundry sand. In the Soil Remedy Area, soil from two sections of the site was placed on the existing land surface beneath an engineered cap. A slurry wall was installed around the cap, and a dual-phase extraction (DPE) system was installed to treat vapor and ground water removed from the contained area. Constructed in 1999, the DPE system began operating in April of that year. The DPE system continues to operate on a cyclic basis, with treated water discharged to the local wastewater treatment plant. Following performance of the qualitative and quantitative evaluations, site contractors used the data obtained to develop final recommendations for the ground-water monitoring networks. In this report, recommendations are made for ground-water sampling frequency and location based on available data pertaining to current hydrogeologic and contaminant conditions.
http://www.cluin.org/download/remed/hyopt/application/PRB_and_Soil_Remedy_Areas_Final_Report.pdf

Long-Term Groundwater Monitoring Optimization: Newark, Muscoy, and Source Operable Units, Newmark Superfund Sites, San Bernardino, California
U.S. EPA, Office of Solid Waste and Emergency Response.
EPA 542-R-07-015, 326 pp, Sep 2007

The goal of long-term monitoring optimization (LTMO) is to review the current ground-water monitoring program and provide recommendations for improving the efficiency and accuracy of the network in supporting site monitoring objectives. Specifically, the LTMO process provides information on the effectiveness of the site characterization, stability of the plume, sufficiency and redundancy of monitoring locations, and the appropriate frequency of network sampling. Because of the extent of affected ground water at the Newmark site, the relatively dilute concentrations, and the subsurface geochemistry, remedial options for the site are limited. The primary interim remedy for the Newmark Site involves ground-water extraction, subsequent treatment with conventional technologies to drinking water standards, and distribution of the water to municipal suppliers. The objectives of the interim remedy are to contain the plume (a dilute plume composed primarily of tetrachloroethene, trichloroethene, dichlorodifluoromethane, and trichlorofluoromethane) and prevent it from migrating to cleaner areas of the aquifer. The remedy for the Newmark OU was completed in 1998, and the Muscoy OU remedy has been in operation since 2005. In 2004, the remedy was supplemented with an institutional controls program crafted to ensure that the function of the pump-and-treat system remains effective in meeting long-term risk-reduction objectives. Currently, ground water at the Newmark Site is monitored at over 160 locations. The primary ground-water monitoring goals for the site include developing a data set to (1) evaluate the efficacy of the chosen remedy to prevent downgradient migration of the plume, (2) evaluate long-term reduction in contaminant mass, and (3) determine if basin activities, such as artificial recharge or ground water or natural processes, are exceeding the capacity of the pumping system to capture the plume. Specifically, monitoring data are used to delineate the extent of affected ground water in support of implementation of institutional controls on the plume. As part of the institutional controls, the Newmark site monitoring data are used to evaluate concentration trends near the extraction front. A secondary objective of ground-water monitoring at the site is to provide data to support ground-water transport modeling efforts.
http://www.cluin.org/download/remed/hyopt/application/Complete_NewmarkReport.pdf

Long-Term Groundwater Monitoring Optimization: Taylor Road Landfill Superfund Site, Seffner, Hillsborough County, Florida
U.S. EPA, Office of Solid Waste and Emergency Response.
EPA 542-R-07-016, 114 pp, Sep 2007

This report reviews and provides recommendations for improving the ground-water monitoring network for Taylor Road Landfill Superfund site, which consists of three closed and adjacent solid-waste disposal facilities. Only one of the three facilities (Taylor Road Landfill) is listed on the National Priorities List. Leachate from the unlined Taylor Road Landfill has affected ground water in an area with agricultural, industrial, and residential land uses, including individual water-supply wells. The primary ground-water monitoring goal for the Taylor Road site is to "define and enclose" ground water exceeding applicable regulatory standards. Monitoring data from the site network are used to support institutional controls by identifying and delineating areas of affected ground water and areas that must be connected to the public water supply. An additional objective of ground-water monitoring is to document natural attenuation of chemical constituents, such as vinyl chloride, trichloroethene, and benzene. The end product of the long-term monitoring optimization process at the Taylor Road Site is a recommendation for specific sampling locations and frequencies that best address site monitoring goals and objectives.
http://www.cluin.org/download/remed/hyopt/application/Complete_TaylorRoadLF_Report.pdf

Low Thermal Mass Gas Chromatography: Analysis at MACH Speed
Wagner, R.E., A.C. Casey, and I. Hotaling, Northeast Analytical, Inc., Schenectady, NY.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Although many advances have been made in gas chromatography (GC and GC/MS) technology, very little has changed for column oven design and operation. Traditionally, GC column ovens are still large, with huge power requirements, limited temperature programming rates, and long cool down times, which dictate the overall speed of analysis. Recently, Low Thermal Mass (LTM(tm)) technology, developed by RVM Scientific, has become commercially available from Gerstel as the Modular Accelerated Column Heater (MACH(tm)). This new technology has increased the speed of analysis dramatically while still maintaining chromatographic resolution. Key to this new technology is that LTM hardware can be retrofitted to GCs currently in use, providing ultra-fast temperature programming with unprecedented cool-down time and very low power consumption. This presentation discusses data obtained from the MACH and lessons learned for dual-column PCB and pesticide analysis, column selection and optimization, and retrofitting MACH hardware to instrumentation not currently supported by the manufacturer. Several case studies are discussed to illustrate how fast GC analysis can provide benefit to the contract lab industry as well as to the professional who uses lab services.

Mapping and Assessment of Degraded Land in the Heihe River Basin, Arid Northwestern China
Qi, Shanzhong and Yumin Cai.
Sensors, Vol 7 No 11, p 2565-2578, 2007

The status of degraded land in the Heihe River Basin in China relevant to its distribution, extent, and precise characteristics is often inadequately known. Field observations and Landsat thematic mapper (TM) images from the year 2003 provided data that allowed classification and evaluation of the 5 types of degraded land in the river basin: water-eroded in the southern mountains, sandified and vegetation-degraded near the oases, aridized in the low reaches, and salinized in the lowlands. The total degraded area covers 29,355.5 sq km, which is 22.58% of the land in the study area. The degraded land in the Heihe River Basin also was evaluated according to changes in the physical structure and chemical components of soils, land productivity, secondary soil salt, and water conditions.
http://www.mdpi.net/sensors/list07.htm

Measurement and Modeling of Ecosystem Risk and Recovery for In Situ Treatment of Contaminated Sediments
Luthy, R.G., E. Janssen, S. Ahn, and J. Tomaszewski (Stanford Univ., Stanford, CA); S.N. Luoma and J.K. Thompson (U.S. Geological Survey).
Abstracts: 2007 SERDP & ESTCP Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, December 4-6, 2007

Project ER-1552 addresses comprehensive strategies to assess the ecological recovery of a contaminated site after in situ treatment by activated carbon amendment, as at Hunters Point, San Francisco Bay, CA. The work includes testing of two rapid assessment tools to measure PCB sediment pore water concentrations: polyethylene sampling devices (PEDs) and a PCB immunoassay. The tools are being tested in the laboratory and validated in the field, and the results correlated with those obtained using conventional methods. Laboratory tests will demonstrate that PCB pore water concentrations are also indicators of PCB mass transfer to activated carbon particles. Regional surveys will determine the benthic species recruitment pool for the Hunters Point area at locations with a similar salinity regime and general physical habitat as at South Basin. A biodynamic modeling approach will be used to predict the uptake of PCBs by three important classes of benthic organisms and elucidate important biodynamic parameters. Once the physiological coefficients have been defined, the applicability of the biodynamic model will be demonstrated in the field. A general ecosystem recovery model will be developed and applied to predict which critical taxa may re-colonize following treatment. This model will be based on the biodynamic modeling approach. Establishing correlations between conventional and alternative measurement tools (PEDs and PCB immunoassay) in the field will allow members of the scientific community to confidently use the rapid, inexpensive tools in the future to assess the ecological recovery of a contaminated sediment site after treatment or during a monitored natural recovery. Biodynamic modeling will result in a general predictive ecosystem recovery model that is directly applicable to any contaminated sediment site, given some knowledge of the species inhabiting the local community and basic information about taxa-specific biodynamics for the contaminants of interest. Ideally, future researchers will need only to measure contaminant pore water concentrations and collect information concerning the benthic organism recruitment pool to predict the extent of ecosystem recovery following remediation.

Measuring Energetics Residues on Snow
Walsh, M.R., M.E. Walsh, and C.A. Ramsey.
ERDC/CRREL TR-07-19, 34 pp, Oct 2007

Quantifying energetics residues resulting from firing and detonating military munitions are necessary components in developing range sustainability models and plans. Determination of the residue plume area, discrimination from previous activities, separation of the residues from the collection matrix, and processing of the samples are all difficult tasks when dealing with residues on soils. To circumvent these problems, the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) has been sampling for energetics residues on snow. At firing points, a clean snow surface allows the collection of residues from a known quantity and type of munition, and testing can be performed in conjunction with a scheduled training exercise. Detonation residues from live-fire training can be sampled on a snow-covered surface in an active impact area when the area fired into has not been utilized since the last snowfall. Tests with blown-in-place munitions can be conducted on clean snow-covered surfaces on active impact areas as well. This report outlines the methods developed by CRREL over the last seven years for sampling residues on snow and deriving estimates for energetics residues on a per-round basis. Sampling, quality control, and sample processing methods are covered.
http://www.crrel.usace.army.mil/library/technicalreports/ERDC-CRREL-TR-07-19.pdf

Microbiological, Geochemical and Hydrologic Processes Controlling Uranium Mobility: An Integrated Field-Scale Subsurface Research Challenge Site at Rifle, Colorado
Long, P., Pacific Northwest National Laboratory, Richland, WA.
Geological Society of America Abstracts with Programs, Vol 39 No 6, p 259, Paper 92-9, 2007

At the Uranium Mill Tailings Site in Rifle, CO, field-scale experiments with acetate as the electron donor have stimulated metal-reducing bacteria to remove uranium [U(VI)] from groundwater. The shallow depth to groundwater (3 to 4 m), thin saturated zone (~2.5 m), and well-defined groundwater flow system at the Rifle site facilitate the monitoring of microbial and geochemical processes. This study has led to two important findings: decreased U(VI) bioreduction after the transition from iron reduction to sulfate reduction, and continued U(VI) removal from groundwater after the termination of acetate amendment, with removal increasing during the following 18 months. The research planned for the Rifle site aims to gain a comprehensive and mechanistic understanding of the microbial factors and associated geochemistry controlling uranium mobility so that DOE can confidently remediate uranium plumes and support long-term stewardship of uranium-contaminated sites. Four hypotheses that address knowledge gaps in the following areas will be tested: (1) geochemical and microbial controls on stimulated U(VI) bioreduction by iron-reducers, (2) U(VI) sorption under Fe-reducing conditions, (3) post-biostimulation U(VI) stability and removal, and (4) rates of natural bioreduction of U(VI). Hypotheses will be tested with focused field and lab experiments that use recently developed sciences of proteogenomics and stable-isotope probing to track microbial metabolic status during acetate amendment. This information will be linked to changes in Fe redox status and sulfide minerals, with field-scale changes detected by non-invasive hydrogeophysics, including 3-D resistivity tomography. This linkage will enable optimization of controllable factors, such as electron donor concentration and identification of nutrient limitations, which if relieved, could enhance bioremediation of redox-sensitive metals.

Microcantilever Sensors for In Situ Subsurface Characterization
Thundat, Thomas G., Gilbert M. Brown, Zhiyu Hu, and Bahua Gu
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 88, 2007

Deployment of inexpensive, miniature, real-time sensors capable of multi-analyte detection with speciation will play a crucial role in characterization, monitoring, and long-term stewardship of subsurface systems. Microfabricated cantilever sensors offer several advantages, including low-power consumption, in situ and real-time operation, extremely high sensitivity, and integration into arrays for multi-analyte detection. Analyte molecule adsorption on a cantilever surface results in cantilever bending when adsorption is confined to a single side. Chemical speciation in sensing is achieved by immobilizing a selective self-assembled monolayer on the cantilever surface. Selectivity for certain analytes can be achieved by using electrochemistry, in which the cantilever undergoes bending as a result of charge transfer processes, producing bending as a function of a cyclic voltage ramp similar to an I-V curve in cyclic voltammetry. Though a microcantilever platform has been demonstrated for in situ detection of individual analytes, a microcantilever array capable of simultaneous detection of multiple analytes, its integration with wireless telemetry, and field deployment are not yet demonstrated. Ideal candidate chemicals of interest fall into two general groups; heavy metals (lead, chromium(VI), mercury, zinc, beryllium, arsenic, cadmium, and copper), and transuranic elements (uranium, neptunium, and plutonium). Although these two general groups and the members of each group are chemically different and have no general molecular recognition characteristics in common, they do have one characteristic in common, in the sense that many are electrochemically active. Many of the heavy metals (generally RCRA waste) exist in groundwater or in mixed wastes as oxidized ionic species (Pb(II), Cr(VI), Hg(II), Cd(II), and Cu(II)) that can be electroplated on gold, platinum, or nickel surfaces. Therefore, SAM coatings, together with electrochemical cantilevers, offer a simple method of achieving selectivity as well as pre-concentration. We have developed SAM coatings that can be used for selective detection of Cs, Hg(II), methyl- Hg(II), Cu(II), Cr(VI), and Cd(II). These SAMs were immobilized by gold-coated silicon cantilevers using thiol chemistry. Initial responses using these SAM layers show extremely high selectivity and robustness. Electrochemical cantilevers have been demonstrated for Cr(VI) and Pb(II). Preliminary results were obtained using optical beam deflection as a signal transduction method. We have designed and developed piezoresistive cantilevers in which cantilever bending results in electrical resistance variation. These silicon piezoresistive cantilevers are electrically insulated with a thin coating of silicon nitride, so that they can be used in aqueous media. The insulated piezoresistive cantilevers will be employed in an array format for simultaneous detection of multiple analytes in mixtures. Cantilevers will also be externally coated with a gold layer for immobilization of SAM. In addition, we have also designed and developed a readout electronic chip that can monitor the response from ten cantilevers simultaneously. We plan to integrate the cantilever platform, readout electronic, and wireless telemetry into a miniature device that can selectively and sensitively detect multiple analytes simultaneously, using battery power.

A Modified Siphon Sampler for Shallow Water
Diehl, Timothy H.
U.S. Geological Survey Scientific Investigations Report 2007-5282, 11 pp, 2007

A modified siphon sampler (a "single-stage" sampler) was developed to sample shallow water at closely spaced vertical intervals. The modified design uses horizontal rather than vertical sample bottles. Previous siphon samplers are limited to water about 20 centimeters (cm) or more in depth; the modified design can sample water 10 cm deep. Several mounting options were used to deploy the modified siphon sampler in shallow bedrock streams of Middle Tennessee, while minimizing alteration of the stream bed. Sampling characteristics and limitations of the modified design are similar to those of the original design. Testing showed that the modified sampler collects unbiased samples of suspended silt and clay. Similarity of the intake to the original siphon sampler suggests that the modified sampler would probably take downward-biased samples of suspended sand. Like other siphon samplers, it does not sample isokinetically, and the efficiency of sand sampling can be expected to change with flow velocity. The sampler needs to be located in the main flow of the stream, and is subject to damage from rapid flow and floating debris. Water traps were added to the air vents to detect the flow of water through the sampler, which can cause a strong upward bias in sampled suspended-sediment concentration. Water did flow through the sampler, in some cases even when the top of the air vent remained above water. Air vents need to be extended well above maximum water level to prevent flow through the sampler. http://pubs.usgs.gov/sir/2007/5282/

Molecular Analysis of the Metabolic State of Geobacter Species During In Situ Uranium Bioremediation
Holmes, Dawn E., Paula Mouser, Hila Elifantz, Carla Risso, Milind Chavan, Regina A. O'Neil, Lorrie Adams, Maria Juliana Larrahando, and Derek R. Lovley (PI)
Department of Microbiology, University of Massachusetts, Amherst, MA
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 63, 2007

To understand the factors controlling subsurface microbial processes, such as in situ bioremediation of metal contaminants, it is necessary to not only identify which microorganisms are responsible for these processes, but also to evaluate their in situ rates of metabolism and how different environmental factors affect the rate and extent of processes of interest. We are investigating the hypothesis that quantifying transcript levels for key metabolic and respiratory genes can provide insight into the metabolic state of the Geobacter species catalyzing in situ bioremediation of uranium-contaminated groundwater. To identify genes whose expression levels could be linked to rates of respiration and/or environmental stresses that might limit the growth and activity of Geobacter species during growth in the subsurface, gene expression patterns were evaluated with whole-genome microarrays and quantitative RT-PCR in two species of Geobacter. This included G. sulfurreducens, which has been the subject of intense physiological investigation, and G. uraniumreducens, which was isolated from the Environmental Remediation Sciences Program study site in Rifle, Colorado, and is representative of the Geobacter species that predominate during in situ uranium bioremediation. For example, to identify genes potentially diagnostic of growth rate in the subsurface, both Geobacter species were grown in chemostats at different dilution rates. Genes that were more highly expressed at high growth rates than at low growth rates (rpsC, accA, ftsZ, rapA, rpsO, rplL, secF, and purF) were identified, as were a number of housekeeping genes whose expression was not affected by growth rate changes (proC, rho, pyk, alaS, gluM, coaBC, pheA, glnA, hisH, and hisS). Initial results from the analysis of transcript levels in the subsurface during in situ uranium bioremediation demonstrated that transcript levels of rpsC normalized against transcript levels of proC varied with rates of Fe(III) reduction in the subsurface. When Geobacter species grown either in chemostats or sterilized sediments from the Rifle site were stressed with 5%, or 10% oxygen for a day, there was a linear increase in transcript levels for oxidative stress genes such as sodA, rbr, rbo, cydA, cydB, hybA, and hybB. Geobacter species expressed the oxidative stress genes, sodA and cydA during in situ uranium bioremediation, suggesting that Geobacter species were exposed to oxidative stresses during the uranium bioremediation process. Other potential metabolic marker genes identified by genetic and gene expression studies included gur1, gur2, and gur3, genes for three putative sodium solute symporters that are highly conserved in the available genomes of Geobacter species and appear to be involved in acetate metabolism. Microarray and quantitative RT-PCR analysis of the expression of these genes indicated that gur1 and gur2 are more highly expressed when growth is limited by acetate availability than when there is an excess of acetate, whereas expression of gur3 appears to be constitutive. Studies are under way to determine whether monitoring expression of these genes in the subsurface can provide an indication of when Geobacter species are limited by acetate availability. These results, coupled with results reported in the previous two years, suggest that it is possible to monitor the metabolic state of Geobacter species during in situ uranium bioremediation. This provides information on how to optimize the bioremediation strategy.

Monitoring Bioremediation in Oil Contaminated Soils Using Toxicity Analysis
Al-Mutairi. N.Z. and M.S. Al-Mutairi.
CEST2007: Proceedings of the 10th International Conference on Environmental Science & Technology, 5-7 September 2007, Kos Island, Greece. p A-16-21, 2007

A tiered toxicity approach was used to track oil degradation at the oil lakes in Kuwait. Three soils from different locations with a history of hydrocarbon contamination were treated in bench-scale microcosms under conditions that had promoted mineralization of total hydrocarbon in a prior study. Bioremediation was monitored using the solid-phase Microtox test and earthworm survival assays. Total petroleum hydrocarbon (TPH) concentrations in soil A had not changed by 150 days. Although an 85% TPH decrease in soil B was observed after 120 days, results of the earthworm and Microtox tests suggested an initial increase in toxicity, indicating that toxic intermediary metabolites may have formed during biodegradation. Between 150 days and 200 days, a considerable decrease in toxicity levels occurred in soils B and C, although TPH and PAH concentration did not change during the last 50 days of treatment. When Microtox is used as a monitoring tool, quantitative changes may be used to evaluate the efficacy of spill response and mitigation techniques. The Microtox system also could be used to assess the efficacy of bioremediation, chemical cleaning, mechanical removal, and "no treatment" options. The results not only establish Microtox values and method detection limits for a wide range of different oils, but also provide additional information to environmental engineers who must decide whether additional cleanup, such as bioremediation, is required. Clearly, toxicity values, and not just concentration, is a key factor in assessing residual bioremediation endpoints. Field chemistry data showed a significant change in oil contamination after the biological treatment.

Comparison of the chemistry monitoring data and the toxicity data showed a poor correlation between oil loss and sediment toxicity.
http://www.srcosmos.gr/srcosmos/generic_pagelet.aspx?pagelet=Article%20summary&pub_id=9638

Monitoring Particulate Matter Using Magnetic Properties of Tree Leaves in the Porto Urban Area (Northern Portugal)
Sant'ovaia, H., R. Barbosa, and H. Ribeiro (Univ. of Porto, Portugal); C. Gomes (Univ. of Coimbra, Portugal).
Geological Society of America Abstracts with Programs, Vol 39 No 6, p 64, Paper 22-25, 2007

The magnetic susceptibility of tree leaves has been used as a proxy to evaluate particulate matter (PM10) quantity and road traffic contribution to air pollution. To evaluate pollution levels, 6 sampling zones were chosen in the urban area of Porto. Sampling was carried out in the first week of July and August 2006. Leaves from deciduous species (Nerium oleander and Quercus sp.) and evergreen species (Tilia sp. and Platanus sp.) were sampled on a total of 32 sites. Magnetic susceptibility measurements were performed within a day after sampling using an Agico Kappabridge (KLY-4S) susceptometer working at a low alternating inductive field (+/- 4x10(-4) T, 920 Hz) and the values calculated by mass. Mass susceptibility values ranges are presented.

Multi-Increment TCE Vadose Zone Investigation
Hewitt, A.D. and S. Bigl (U.S. Army ERDC-CRREL); C.A. Ramsey (EnviroStat, Inc.).
Abstracts: 2007 SERDP & ESTCP Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, December 4-6, 2007

A study was conducted at a site where an underground tank positioned above a concrete pad was used to store TCE for 12 years. An odor of TCE was evident during excavations when the original tank, a replacement tank used for fuel oil, and the concrete pad were removed from the site. The extent of contamination was quantified a few years later, using over 500 discrete samples to define the zone with the highest concentrations (sometimes exceeding 1% wt/wt of TCE). The highly contaminated zone was a 3,000 cubic m volume measuring 11 m by 22 m in surface area and 12 m deep. In 2006, both multi-increment and discrete sampling strategies were used to estimate the average concentration and the three-dimensional distribution of TCE in the zone of interest. A total of 188 discrete and 41 multi-increment samples was obtained for the evaluation. Each discrete sample was an individual 5-g (3-cc) plug of soil. The majority of the multi-increment samples contained 40 of the 5-g soil plugs. The multiple increments were combined in two ways -- within an individual borehole and within 0.6-m subsurface depth intervals. Both sampling strategies established similar average TCE concentrations; however, the discrete sample average was heavily influenced by a single sample with a concentration very different from the rest. More importantly, the discrete sampling strategy failed to identify two layers in a soil boring where the TCE concentrations exceed 1% w/w. This omission would lead to a gross underestimation of the contamination mass (volume with >1% TCE), which could trigger a false-negative action, or the improper design and subsequent low cost estimation for remedial technologies. Additionally, this study identified large economical advantages to using the multi-increment sample strategy and combining the increments in two directions, which inherently establishes two independent values, allowing for quality assurance data confirmation. Multi-increment sampling also allows for a lot more increments (and sample mass) from the zone under investigation to be included in the analysis, for no additional cost other than that of the solvent. This sampling strategy is well suited for identifying the location of high concentrations of TCE and most likely many other VOCs in subsurface zones.

Multi-Instrumental Investigation of Affecting of Early Somatic Embryos of Spruce by Cadmium(II) and Lead(II) Ions

Supalkova, V., J. Petrek, J. Baloun, V. Adam, K. Bartusek, L. Trnkova, M. Beklova, V. Diopan, L. Havel, and R. Kizek.

Sensors, Vol 7 No 5, p 743-759, 2007

A multi-instrumental analytical apparatus was used to investigate the effects of treatment with cadmium(II) and/or lead(II) ions (50, 250 and 500 uM) on early somatic spruce embryos (ESEs) over a 12-day period. Image analysis was used for estimation of growth and a fluorimetric sensor for enzymatic detection of viability of the treated ESEs. Results indicate that Cd caused higher toxicity to ESEs than Pb. The ESEs grew and developed better in the presence of 500 uM of the metal ions than in the presence of 250 uM. Based on the results obtained using nuclear magnetic resonance, this phenomenon was related to an increase of the area of ESE clusters by intensive uptake of water from the cultivation medium, due to dilution of the heavy metal concentration inside the cluster. The glutathione (GSH) content in treated ESEs was examined by the adsorptive transfer stripping technique coupled with the differential pulse voltammetry Brdicka reaction. GSH plays an important role in detoxification of toxic heavy metals and scavenging of reactive oxygen species. GSH contents increased up to 148 ng/mg (clone 2/32) and 158 ng/mg (clone PE 14) after 12 days of treatment with Cd-EDTA ions. The GSH content was about 150 and 160% higher in comparison with the ESEs treated with Pb-EDTA ions, respectively. The difference between GSH contents determined in ESEs treated with Pb-EDTA and Cd-EDTA ions correlates with the higher toxicity of cadmium(II) ions.
http://www.mdpi.net/sensors/list07.htm

Munitions and Explosives of Concern (MEC) Investigation of an Open Burn/Open Demolition (OB/OD) Area

Healy, E. (ICF International, Lexington, MA); S. Holt (US Army Corps of Engineers, New England District, Concord, MA); V.L. Rystrom (Risk Reduction Resources, Harpers Ferry, WV).

The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

An 8-acre Formerly Used Defense Site (FUDS) currently lies within the boundaries of a Massachusetts State Park. The issues associated with this site are common to many of the FUDS that contain known munitions OB/OD areas or landfills at former facility/base sites where munitions historically were present. Given the past use of the site, the probability of MEC being present was considered very low; however, because it was an OB/OD area, the possibility of MEC needed to be investigated further and resolved at an acceptable risk level. To accomplish this goal in a technically robust, cost-effective manner, a multi-tiered site investigation approach was developed, based on the assumptions that the actual disposal area was very small and that there was likely no MEC outside the disposal pit. Several lines of evidence were used to identify the disposal area, including review and analysis of anecdotal history, aerial photographs, soil and groundwater chemical data, contaminant fate and transport, magnetometer screening data, and subsurface boring records. Based on this analysis, the actual OB/OD area was estimated at 0.2 acre. Geophysics is the standard initial approach to investigating MEC sites and identifying potential MEC items, but the OB/OD pit is problematic because the amount of scrap shows a saturated geophysical response, and it must be investigated through subsurface excavation. The first phase of geophysics work was mag and flag, done with the objective of screening the entire site, and identifying some portion of the 8 acres for further investigation. However, the mag and flag resulted in over 1,400 points being flagged as potential MEC targets throughout the entire site, excluding the suspected disposal pit. The subsequent phase involved an electromagnetic (EM) survey of the site, excluding the disposal pit, to provide improved geophysical data. Saturated geophysical results from the EM survey indicated that the disposal area may be more than 7 times larger than anticipated. The final phase of the investigation included excavation to ground truth the geophysical data.

New Evaluation Scheme for Two-Dimensional Isotope Analysis to Decipher Biodegradation Processes: Application To Groundwater Contamination by MTBE
Zwank, Luc, Michael Berg, Martin Elsner, Torsten C. Schmidt ; René P.Schwarzenbach, and Stefan B.Haderlein
Environmental Science & Technology, Vol 39 No 4, p 1018-1029, 2005

Isotopic analyses were used to identify the source and degradation mechanism of methyl tert-butyl ether (MTBE) at an industrial site with multiple contaminants and contaminant sources. Because of the complexity of the site, an approach different from mass balance was needed. The analyses showed that the isotopic composition of MTBE steadily changed from the source regions along the major contaminant plume axis and that these changes indicated biodegradation was occurring. The presence of tert butyl alcohol (TBA) confirmed this; however the TBA carbon ratios did not support its degradation. Site data were compared with published carbon and hydrogen isotope fractionation data for biodegradation of MTBE under oxic and anoxic conditions indicated that anaerobic biodegradation of MTBE was occurring along the entire plume. The authors present a novel scheme to evaluate empiric isotopic enrichment factors in terms of kinetic isotope effects which show that MTBE degradation follows a S_N2-type reaction mechanism.

New Soil VOC Sampler: ACCU Core(r) Sampling/Storage Device for VOC Analysis
Sorini, S.S., J.F. Schabron, and M.M. Sanderson.
WRI-07-R011, 71 pp, Apr 2007

The Accu Core(r) sampler system consists of alternating cylindrical clear acrylic sections and one-inch cylindrical stainless steel sections arranged in clear shrink wrap. The set of alternating acrylic and stainless steel sections in the shrink wrap are designed to fit in a Geoprobe(r) dual-tube penetrometer for collection of continuous soil cores. The clear acrylic sections can have half-inch access holes for easy soil headspace screening without violating the integrity of the adjacent stainless steel sections. The Accu Core sampler system can be used to store a soil sample collected in the stainless steel section by capping the ends of the section so it becomes a sample storage container. The sampler system can also be used to collect a subsurface soil sample in one of the sections that can be directly extruded from the section into a container for storage during shipment to the laboratory. In addition, the soil in a sampler section can be quickly sub-sampled using a coring tool and extruded into a storage container so the integrity of the soil is not disrupted and the potential for VOC loss during sub-sampling is greatly reduced. A field validation study was conducted to evaluate the performance of the Accu Core sampler to store VOC soil samples during transportation to the laboratory for analysis and to compare the performance of the Accu Core with current sampling and storage techniques, all of which require sub-sampling when the soil sample is brought to the surface. During some of the validation testing, the acrylic sections having access holes for headspace screening were included in the Accu Core sampler configuration and soil in these sections was screened to show the usefulness of the sample screening capability provided by the Accu Core system. This report presents the results of the field validation study as well as recommendations for the Accu Core sampler system. http://www.osti.gov/bridge/servlets/purl/908781-YfYcqT/

No-Purge Groundwater Sampling Evaluation at the Massachusetts Military Reservation
Greenberg, M. and N. Tindall (CH2M HILL, Otis ANG Base, MA); R. Forbes (AFCEE).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

No-purge groundwater sampling enables the passive collection of a groundwater sample from a discrete interval within a monitoring well screen without the pumping or purging required by conventional techniques. No-purge sampling relies upon the natural advective movement of groundwater through an open well screen. After sufficient time has elapsed for the sampling device to stabilize, the resulting sample is considered representative of the aquifer conditions immediately adjacent to the well screen. The primary advantage of using the no-purge technique is the cost savings associated with reduced sampling time, reduced equipment and materials, and elimination of purge water when compared to sample collection through conventional methods using pumps. The feasibility of integrating the no-purge sampling methodology into a large groundwater monitoring program was evaluated at the Massachusetts Military Reservation (MMR), where at least 1,500 monitoring wells are sampled each year. The cost benefits of integrating this technology into such as large monitoring program could be considerable. Two types of no-purge sampling devices were tested and evaluated: the passive diffusion bag sampler (PDB) and the HydraSleeve(r) sampler. A series of side-by-side sampling tests were performed that evaluated the performance of PDBs vs. the traditional low-flow pump sampling techniques, and PDBs vs. HydraSleeve(r) samplers. The testing consisted of a comparison of the analytical data generated using each sampling technique, a qualitative assessment of the useability of the sampling devices, and an evaluation of the potential cost savings of using no-purge techniques against the conventional low-flow pump methods. In addition, the evaluation reviewed the overall benefits and limitations of the no-purge samplers tested against the traditional low-flow pump sampling techniques currently being utilized at the MMR.

Nonlinear Bayesian Algorithms for Gas Plume Detection and Estimation from Hyper-Spectral Thermal Image Data
Heasler, P., C. Posse, J. Hylden, and K. Anderson, PNNL, Richland, WA.
Sensors, Vol 7 No 6, p 905-920, 2007

This paper presents a nonlinear Bayesian regression algorithm for detecting and estimating gas plume content from hyperspectral data. Remote sensing data, by its very nature, is collected under less controlled conditions than laboratory data. As a result, the physics-based model used to describe the relationship between the observed remote-sensing spectra and the estimated terrestrial (or atmospheric) parameters typically are littered with many unknown "nuisance" parameters. Bayesian methods are well-suited for this context as they automatically incorporate the uncertainties associated with all nuisance parameters into the error estimates of the parameters of interest. This paper illustrates the nonlinear Bayesian regression methodology on simulated data from a three-layer model for long-wave infrared (LWIR) measurements from a passive instrument. The generated LWIR scenes contain plumes of varying intensities, and this allows estimation uncertainty and probability of detection to be quantified. The results show that this approach should permit more accurate estimation as well as a more reasonable description of estimate uncertainty. Specifically, the methodology produces a standard error that is more realistic than that produced by matched filter estimation.
http://www.mdpi.net/sensors/list07.htm

A Novel Gas Sensor Transducer Based on Phthalocyanine Heterojunction Devices
Muzikante, I., V. Parra, R. Dobulans, E. Fonavs, J. Latvels, and M. Bouvet.
Sensors, Vol 7 No 11, p 2984-2996, 2007

Experimental data concerning the changes in the current voltage (I-V) performances of a molecular material-based heterojunction consisting of hexadecafluorinated nickel phthalocyanine (Ni(F16Pc)) and nickel phthalocyanine (NiPc), (Au-Ni(F16Pc)NiPc-Al) are introduced as an unprecedented principle of transduction for gas-sensing performance. The respective n- and p-type doped-insulator behaviors of the respective materials are supported owing to the observed changes in surface potential (using the Kelvin probe method) after submission to electron donor (ammonia) and electron acceptor gases (ozone). The bilayer device exhibits strong variations in the built-in potential of the junction and in its rectification ratio. Moreover, large increases occur in forward and reverse currents in presence of ammonia vapors, which make possible a multimodal principle of detection controlled by a combined effect between the heterojunction and the NiPc-Al contact. This metal/organic junction plays a critical role regarding the steady asymmetry of the I-V profiles during the device's doping, even using high ammonia concentrations. This approach offers a more sophisticated alternative to the classically studied but at times operation-limited resistive gas sensors.
http://www.mdpi.net/sensors/list07.htm

An Optical Biosensor Based on Immobilization of Laccase and MBTH in Stacked Films for the Detection of Catechol
Abdullah, J., M. Ahmad, L.Y. Heng, N. Karuppiah, and H. Sidek.
Sensors, Vol 7 No 10, p 2238-2250, 2007

This paper describes the fabrication of an optical biosensor using stacked films where 3-methyl-2-benzothiazolinone hydrazone (MBTH) was immobilized in a hybrid nafion/sol-gel silicate film and laccase in a chitosan film for the detection of phenolic compounds. Quinone

and/or phenoxy radical product from the enzymatic oxidation of phenolic compounds was allowed to couple with MBTH to form a colored azo-dye product for spectrophotometric detection. The biosensor demonstrated a linear response to catechol concentration range of 0.5-8.0 mM, with a detection limit of 0.33 mM and response time of 10 min. The reproducibility of the fabricated biosensor was good with RSD value of 5.3 % (n = 8) and stable for at least 2 months. The use of the hybrid materials of nafion/sol-gel silicate to immobilize laccase has altered the selectivity of the enzyme to various phenolic compounds, such as catechol, guaicol, o-cresol, and m-cresol, when compared to the nonimmobilized enzyme. When immobilized in this hybrid film, the biosensor responds only to catechol and not to other phenolic compounds tested. Immobilization in this hybrid material enables the biosensor to be more selective to catechol compared with the nonimmobilized enzyme. This shows that by a careful selection of different immobilization matrices, the selectivity of an enzyme can be modified to yield a biosensor with good selectivity toward targeted analytes.
http://www.mdpi.net/sensors/list07.htm

ORS-Based Air Monitoring During an MGP Site Cleanup: A Case Study
Minnich, Timothy R. and Robert L. Scotto, Minnich and Scotto, Inc., Stuart P. Schulz, Jr., Atmos Energy Corporation, Stephen H. Perry, Kassay Field Services, Inc.
The A&WMA 98th Annual Conference and Exhibition, June 2005, Minneapolis, Minnesota.

An ambient air monitoring program was employed as part of a removal action at a former manufactured gas plant site in Bristol, Tennessee to ensure that communities downwind maintained safe ambient-air conditions. The monitoring program was also intended to support on-site decision making on mitigative measures, in the event that pre-established levels were exceeded. Target volatile organic compounds and polycyclic aromatic hydrocarbons were measured in real time using a Fourier-transform infrared (FTIR) spectrometer. Meteorological conditions were continuously monitored, and offsite contaminant exposure was assessed using the cross-sector-averaging technique. The data were used to calculate maximum exposure levels during each monitoring event. Results are presented in this paper.
http://msiair.net/web%20-%20Paper%205.pdf

Performance Evaluation Using Expert Elicitation and Long Term Environmental Monitoring Optimization for Long Term Stewardship
Moore, B., J. Ditmars, B. Minsker, and J. Bachmaier.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June, Orlando, Florida. Florida State Univ., Tallahassee, 4 pp, 2001

Long-term environmental monitoring is a critical component of stewardship. The data provide ongoing evidence of environmental compliance and protection of the public and the environment; the monitoring program, in part, determines the life cycle cost and extent of stewardship; and the monitoring program provides a framework to develop trust and agreement between the site steward, stakeholders, and public. Quantitative performance evaluation of the restoration or waste site system over a given compliance period (e.g., 30 to 100 years) provides a mechanism for (1) estimating parameter and model uncertainties and sensitivities, (2) establishing long term monitoring objectives and metrics, (3) eliminating or reducing uncertainties in the system model, and (4) knowing when to cease monitoring. Often, the site

performance evaluation is risk- and probability-based--a powerful quantitative tool to assess predictions, remedies, and institutional control approaches. This paper contains a discussion of performance evaluation using expert elicitation as a precursor to long-term monitoring program design, and later as an iterative tool to optimize and validate system management.
http://www.containment.fsu.edu/cd/content/pdf/470.pdf

Pilot Installation for the Thermo-Chemical Characterisation of Solid Wastes
Marculescu, C., G. Antonini, A. Badea, and T. Apostol.
Waste Management, Vol 27 No 3, p 367-374, 2007

In waste-to-energy operations, the various types of wastes require the operator to adjust the thermal treatment units to adapt the installations or the functioning parameters to the different physical and chemical properties of the wastes. The treated waste usually is encountered in the form of heterogeneous mixtures. The classical tests, such as thermogravimetry and calorimetric bomb, operate component by component and can analyze only small quantities of waste at a time. These common tests are necessary but insufficient to the need. An experimental installation was designed and built at the CNRS Science Division, Department of Industrial Methods, Compiegne University of Technology, France, that allows the determination and continual analysis of waste thermal and chemical properties by thermal treatment. The installation reproduces the process conditions from incinerators or pyrolysis reactors and provides complete information on the kinetics of the waste thermal degradation and on the pollutant emissions.
http://www.aseanenvironment.info/Abstract/41014350.pdf

Polymer-Encapsulated Soil as an In Situ Methodology to Assess Long-Term Performance of Soil-Immobilized Contaminants
Spalding, Brian and Scott C. Brooks
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 83, 2007

Any methodology to assess the long-term performance of immobilized contaminants in soil must be able to demonstrate both (1) measurable contaminant immobilization in some unavailable phase, such as a stable mineral or microbial cells, and (2) the permanence of that immobilized phase under prevailing in situ geochemical conditions after active manipulation can no longer be sustained. Relatively little attention has been paid to the latter criterion, owing, in part, to the technical difficulty and expense of collecting the large number of soil samples required to decipher statistically significant effects over time, in an all-too-heterogeneous soil environment. In this new FY2007 project, nondestructive assay techniques, using both x-ray fluorescence and gamma spectroscopy, will be applied to soils contained within permeable environmental leaching capsules (PELCAPs) and obtained from the ERSD Field Research Center (FRC) in Oak Ridge, TN (and other areas where either natural attenuation or in situ immobilization treatments for U, Tc, Cr, 90Sr, and 137Cs have occurred). Repeated retrieval and replacement of PELCAPs in groundwater will be performed to obtain a long-term time series of contaminant concentrations under in situ field conditions. Polyacrylamide, as a soil-encapsulating gel, has been found previously to allow radioisotopes of cesium and strontium to diffuse freely, rapidly, and completely from and into small cylindrical soil capsules during limited field testing. Thus, gel-contained soils now present a novel and powerful tool for nondestructive assay of contaminants in the same soil samples repeatedly, while allowing them to weather in situ under ambient physiochemical conditions. The resulting observational time series of U, Tc, Cr, 90Sr, and 137Cs contaminant concentrations will provide the capability to assess in situ the long-term performance of immobilized contaminants. The primary application will be to assess U, Tc, Cr, 90Sr, and 137Cs immobilization in treated and untreated or naturally-attenuated soils in uncontaminated groundwater environments at the FRC and ORNL' White Oak Creek watershed under both aerobic and anaerobic conditions. The major hypothesis to be tested is that changes of <1% per year in the total immobilized amounts of U, Tc, Cr, 90Sr, and 137Cs in soil can be detected in situ using such encapsulated soil specimens. Such temporal resolution will allow the observation of the asymptotic approach to the final immobilized fraction within each test soil. Precise contaminant retention performance in the field will provide, for the first time, a sensitive methodology to support selections and quantitative comparisons of both natural attenuation or soil contaminant immobilization techniques. Preliminary uptake and release of U and Th from PELCAPs at the FRC will be discussed.

Processing of Training Range Soils for the Analysis of Energetic Compounds

Hewitt, A., S.Bigl, M. Walsh, S. Brochu, K. Bjella, and D. Lambert
ERDC/CRREL TR-07-15, 34 pp, Sep 2007

Large soil samples are often necessary to represent areas where analytes are distributed as particulates. Proper processing of these large samples impose additional time, space, and equipment requirements on the laboratory community servicing environmental programs to investigate military training ranges. Part of this study evaluated the robustness of two methods used to process large soil samples for the determination of energetic munitions residues: whole-sample mechanical grinding (comminution) and solvent dissolution. Both methods have been used successfully to reduce subsampling variance for samples collected on training ranges where particles of energetic residues have accumulated; however, two energetic compounds frequently detected in such samples--nitroglycerin (NG) and 2,4-dinitrotoluene (2,4-DNT)--may be susceptible to evaporative losses during solvent dissolution. Robustness experiments involved both lab-spiked and field-collected soils with various concentrations of energetic residue. An experiment utilizing field-collected soils involved the use of a rotary splitter. Even with this highly regarded equipment, the samples could not be split consistently, preventing a direct comparison of the two techniques in soils with residue concentrations less than 40 mg/kg. Two other investigations evaluated sample holding times and cross-contamination resulting from grinding processes. The results indicated that energetic compounds typically found on military training ranges were stable in air-dried soils for periods in excess of 53 days when stored in the dark at room temperature. A slight amount of cross-contamination from grinding was detectable using gas chromatography. The concentrations were below detectable levels when using liquid chromatography and were eliminated by supplementing the cleaning protocol with a step of soaking the grinding bowl in a sonic bath filled with dilute cleaning detergent.
http://www.crrel.usace.army.mil/library/technicalreports/ERDC-CRREL-TR-07-15.pdf

PVDF Coated Quartz Crystal Microbalance Sensor for DMMP Vapor Detection
Ying, Z., Y. Jiang, X. Du, G. Xie, J. Yu, and H. Wang, Univ. of Electronic Science and Technology of China (UESTC), Chengdu.
Sensors and Actuators B: Chemical, Vol 125 No 1, p 167-172, 16 July 2007

A quartz crystal microbalance (QCM) modified with poly(vinylidene fluoride) (PVDF) was fabricated using a drop-coating method and applied to the detection of dimethyl methylphosphonate (DMMP) vapor. DMMP is a nerve-agent simulant. Measurements were based on the frequency shifts due to the adsorption of DMMP vapor on the surface of the modified electrodes. Frequency shifts were found to be linear to the concentrations of analyte in the range of 5 to 60 ppm with a correlation coefficient > 0.997. The influences of temperature and humidity on the sensors were also examined. Sensor sensitivity to DMMP vapor was almost identical regardless of humidity levels but higher at lower temperatures.

Quantifying Deep Vadose Zone Soil Water Potential Changes at a Waste Disposal Site
Hubbell, Joel M. and Deborah L. McElroy.
INL/CON-07-13086, 8 pp, 2007

Recent advances in moisture monitoring using tensiometers has resulted in long-duration, high quality data sets from within the deep vadose zone. A network of about 30 advanced tensiometers in 18 wells provided field-scale data to monitor soil water potential conditions and movement in the subsurface in and around a mixed waste disposal site at depths ranging from 6 to over 67 m below land surface. Sensors are located in both sediments and fractured rock within the geologic profile and some have been in operation for over 10 years. The moisture monitoring was able to detect long-term declines in soil water potential in response to lower than normal precipitation and resultant infiltration over the time period from 2000 to 2004. This trend was reversed in 2005 and 2006 in more than half of the monitoring sites over the 6 to 33 m depth interval and in several monitoring sites from 33 to 67 m, in response to above normal precipitation. These tensiometer data have the potential to validate effectively and rapidly that an action such as placement of an evapotranspiration (ET) cover would be successful in reducing the water moisture movement inside the disposal area to levels similar to those in undisturbed sites outside of the disposal area. This paper describes the instrument design, how the instruments were installed, and the data resulting from the use of this monitoring system.
http://www.inl.gov/technicalpublications/Documents/3825718.pdf

Raman Spectroscopy Cell-based Biosensors
Notingher, Ioan, Univ. of Nottingham, UK.
Sensors, Vol 7 No 8, p 1343-1358, 2007

One of the main challenges faced by biodetection systems is the ability to detect and identify rapidly a large range of toxins at low concentrations. Cell-based biosensors rely on detecting changes in cell behavior, metabolism, or induction of cell death following exposure of live cells to toxic agents. Raman spectroscopy is a powerful technique for studying cellular biochemistry. Different toxic chemicals have different effects on living cells and induce different time-dependent biochemical changes related to cell death mechanisms. Cellular changes start with membrane receptor signaling, leading to cytoplasmic shrinkage and nuclear fragmentation. The potential advantage of Raman spectroscopy cell-based systems is that they are not

engineered to respond specifically to a single toxic agent but are free to react to many biologically active compounds. Raman spectroscopy biosensors can also provide additional information from the time-dependent changes of cellular biochemistry. Since no cell labeling or staining is required, the specific time-dependent biochemical changes in the living cells can be used for the identification and quantification of the toxic agents. Thus, detection of biochemical changes of cells by Raman spectroscopy could overcome the limitations of other biosensor techniques, with respect to detection and discrimination of a large range of toxic agents. Further development of this technique may include integration of cellular microarrays for high throughput in vitro toxicological testing of pharmaceuticals and in situ monitoring of the growth of engineered tissues.
http://www.mdpi.net/sensors/list07.htm

Rapid Methods for Dioxin and Dioxin-Like PCBs in Food and Feedingstuffs: State of the Art
Behnisch, Peter A. and Ron Hoogenboom.
Dioxin 2004: 24th International Symposium on Halogenated Persistent Organic Pollutants, Organohalogen Compounds, Vol 66, p 668-676, 2004

The increasing number of local dioxin crises since 2002 is becoming more and more apparent due to stricter controls of feed and food in the European Union and the globally increasing number of countries applying similar guidelines make it necessary to establish reliable, time- and cost-effective screening methods to assess dioxin intake through nutritional pathways. This paper provides an overview of state-of-the-art improvements and a future outlook for chemical and bio-analytical approaches for rapid analyses of dioxins and dioxin-like compounds. Improvements such as PCR, proteomic biomarkers, ASE for methods cleanup, PowerPrep, and different detection methods are in the research and testing phase, as well as other indicators for dioxins, such as correlations to fatty acids.
http://dioxin2004.abstract-management.de/pdf/p497.pdf

Reliable and Cost-Effective Technique for Rapid Evaluation of Dredged Areas in Coastal Lagoons in the Northern Adriatic
Somen-Joksic, A. and R. Milacic.
CEST2007: Proceedings of the 10th International Conference on Environmental Science & Technology, 5-7 September 2007, Kos Island, Greece. p A-1333-1340, 2007

Estimating the potential leaching of contaminants from dredged material requires a well-designed and reliable investigation procedure for improved environmental risk assessment. The absence of a standardized procedure presents difficulties in setting the references and limit or quality criteria values. Potential leachability of copper, zinc, lead, and nickel in dredged marine sediments was studied using different extraction procedures. Results were compared to determine the most reliable procedure with lower costs and more rapid scanning. The procedures studied were (1) single extraction with 25% acetic acid solution, following the United Nations Environment Programme procedure; (2) a leaching test with the seawater, following the German Standard Method procedure, DIN 38414-4; and (3) a 3-step sequential extraction of the Standards, Measurements and Testing Programme. Use of diluted acetic acid in accordance with the UNEP procedure was found to be a cost-effective and rapid technique for evaluation of dredged marine areas and provided reliable information for potential impact assessment of metal

leaching from dredged sediments in non-heavily polluted coastal areas and lagoons in the Northern Adriatic.
http://www.srcosmos.gr/srcosmos/generic_pagelet.aspx?pagelet=Article%20summary&pub_id=9830

Remediation of Petroleum-Contaminated Sites Through Simulation of a DPVE-Aided Cleanup Process: Part 1. Model Development|
Huang, Y.F.; G.H. Huang, A. Chakma, I. Maqsood, B. Chen, J.B. Li, and Y.P. Yang
Energy Sources, Part A: Recovery, Utilization and Environmental Effects v 29 n 4, p 347-365, March 2007

This report describes the development of a hybrid modeling system for simulating dual phase vacuum extraction (DPVE) remediation and contaminant transport. The three-dimensional subsurface model incorporates a numerical simulation of the DPVE remediation process. The model was applied to a petroleum-contaminated site in western Canada where a DPVE system was deployed where it successfully simulated the effects of the DPVE on free-product recovery and contaminant transport.

Remote Real-Time Monitoring and Control of Contamination in Underground Storage Tank Systems of Petrol Products
Sacile, R., CIMA Centro di ricerca Interuniversitario in Monitoraggio Ambientale, Savona, Italy.
Journal of Cleaner Production Approaching Zero Emissions v 15 n 13-14, p 1295-1301, 2007

This paper discusses a fuel release detection system that can be configured to also act as a soil vapor extraction system should a release be detected. The system provides continuous real time detection features. A demonstartion of the system has been going on for more than three years at a service station in Genova, Italy.

Resistivity Level Runs to Detect Water-Filled Mine Voids Between Drill Holes
Moret, Geoff and Arthur Rose.
Mine Water and the Environment, Vol 26 No 1, p 23-28, Mar 2007

Resistivity level runs are collected by lowering a current source down one well and measuring the resulting voltage at the same depth in another well. Mine voids between the wells that contain acid water appear as conductive anomalies on the resulting apparent resistivity profiles. Resistivity level runs can be collected rapidly and without lowering expensive equipment down holes of unknown stability. The data can be interpreted on-site, and are relatively insensitive to positioning errors. The method is well suited to sites where several drill holes have failed to intersect a known mine void. We demonstrated the feasibility of resistivity level run profiling at an abandoned mine complex in central Pennsylvania, where resistivity level runs were successfully used to locate haulage ways containing mine water.

A Resolution Analysis of Two Geophysical Imaging Methods for Characterizing and Monitoring Hydrologic Conditions in the Vadose Zone.
Brainard, J.R. and G. Hammond (Sandia National Laboratories); D.L. Alumbaugh (Univ. of Wisconsin-Madison); D.J. La Brecque (Multi-Phase Technologies, LLC, Sparks, NV).
SAND2007-3539, 73 pp, 2007

This research project analyzed the resolution of two geophysical imaging techniques, electrical resistivity tomography (ERT) and cross-borehole ground penetrating radar (XBGPR), for monitoring subsurface flow and transport processes within the vadose zone. The study was based on petrophysical conversion of moisture contents and solute distributions obtained from unsaturated flow forward modeling. This modeling incorporated boundary conditions from a potable water and a salt tracer infiltration experiment performed at the Sandia-Tech Vadose Zone (STVZ) facility, and high-resolution spatial grids (6.25-cm spacing over a 1700-m domain) and incorporated hydraulic properties measured on samples collected from the STVZ. The process of analysis involved petrophysical conversion of moisture content and solute concentration fields to geophysical property fields and forward geophysical modeling using the geophysical property fields to obtain synthetic geophysical data, followed by inversion of this synthetic data. These geophysical property models were then compared to those derived from the conversion of the hydrologic forward modeling to provide an understanding of the resolution and limitations of the geophysical techniques.
http://www.osti.gov/bridge/product.biblio.jsp?query_id=3&page=0&osti_id=912660

Review of Techniques to Characterize the Distribution of Chromate Contamination in the Vadose Zone of the 100 Areas at the Hanford Site
Dresel, P.E., M.J. Truex, and M.D. Sweeney, Pacific Northwest National Lab.
PNNL-16760, 61 pp, Sep 2007

Characterization of the distribution of chromium concentration in the vadose zone of the 100 Areas at the Hanford site is needed to assess potential sources for chromate plumes in ground water. Although the reviewers identified no fully developed methods for vadose zone chromate characterization, the following technologies were recommended for additional evaluation and testing: laser-induced breakdown spectroscopy, Raman spectroscopy, laser-induced fluorescence, x-ray fluorescence, in situ specific conductance, high-resolution resistivity, partitioning tracers, and neutron moisture logging.
http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16760.pdf

Review on State-of-the-Art in Polymer Based pH Sensors
Korostynska, O., K. Arshak, E. Gill, and A. Arshak.
Sensors, Vol 7 No 4, p 578-588, 2007

This paper reviews current methods based on polymer materials for measuring pH levels. These methods include polymer-coated fiber-optic sensors, devices with electrodes modified with pH-sensitive polymers, fluorescent pH indicators, potentiometric pH sensors, and sensors that use a combinatory approach for ion concentration monitoring.
http://www.mdpi.net/sensors/list07.htm

Role of Bacterial Nanowires in Biogeobatteries
Hill, Eric A., Dimitrios Ntarlagiannis, Estella A. Atekwana, Johannes C.M. Scholten,
and Yuri A. Gorby
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 80, 2007

Biological, geochemical, and physical processes in the subsurface produce gradients of electrical potential that can be measured by a multimeter. Voltage gradients can be used to find oil and map the path of groundwater flow. Recent collaborations between geologists, geophysicists, and biologists have yielded a novel application for the classic geobattery model to explain natural electrical field generation (expressed as self potential, SP) in the subsurface in the absence of metallic minerals. Bacteria have been shown to produce electrically conductive appendages called bacterial nanowires (Gorby, PNAS 103, 11358–11363). We hypothesized that bacterial nanowires contribute to the generation of electrical fields in the subsurface. We constructed models of the subsurface by suspending the bacterium Shewanella oneidensis MR-1 in columns filled with saturated sands. We observed formation of voltage gradients that corresponded to consumption of the carbon source lactate, and formation of bacterial nanowires (observed by SEM during a preliminary experiment). We hypothesize that submerged bacteria gain access to oxygen through a network of nanowires that extend to the air above the saturated sands. The nanowires might transfer electrons from bacteria in the anaerobic part of the column to bacteria at the surface that have access to oxygen. This transport of electrons through bacterial nanowires might be responsible for the produced electrical potential trends. These recent findings will significantly contribute to the understanding of the geophysical signatures associated with microbial activity in contaminated soils, substantially improving current monitoring/ bioremediation techniques. Additionally, the methods can be used to optimize the bioremediation processes by providing spatial and real-time continuous data on the microbial contaminant processes, thus helping to keep optimal conditions for contaminant remediation.

Sampling Sediment Porewater in the Lower Duwamish Waterway Using a Passive Sampler
Hodny, J.W. (W.L. Gore & Associates, Inc.); T.A. Floyd (Floyd and Snider, Inc.).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Membrane-based passive samplers provide a unique screening method to identify and delineate contaminated porewater and sediment. Subsequently, more complex and invasive sampling can then be focused effectively and economically. The Washington State Department of Ecology and the US EPA have been overseeing sediment characterization and cleanup efforts along the Lower Duwamish Waterway, now listed on the NPL. An embayment was investigated to determine whether groundwater contaminated by chlorinated compounds from upgradient sources was entering the river by upwelling through the embayment sediments or through shallow localized seeps. The investigators deployed patented, passive samplers, constructed of GORE-TEX(r) membrane and hydrophobic adsorbents. The passive samplers were driven into the embayment and seep sediment during two phases of investigation. The first phase focused on the embayment area, while the second phase focused on two of the seeps suspected of being the exit points for contaminated groundwater. Sediment samples were also taken and the porewater analyzed. The datasets generated by the passive sampling and the conventional method were closely correlated and confirmed the passive sampler's detection capability in sediment porewater. The samplers proved to be an accurate, sensitive, and easy-to-use porewater sampling tool. Seven years later, porewater sampling using piezometers and peepers also confirmed the original passive sampling results. Passive sampling provided an accurate and economical method to characterize the location and extent of contaminated groundwater entering an embayment in the Lower Duwamish Waterway from an upgradient facility, and focused subsequent sampling efforts.

Satellite Mapping of Oil Spills in the East Mediterranean Sea
Topouzelis, K., O. Muellenhoff, G. Ferraro, and D. Tarchi.
CEST2007: Proceedings of the 10th International Conference on Environmental Science & Technology, 5-7 September 2007, Kos Island, Greece. p A-1433-1440, 2007

Different types of routine ship operations lead to deliberate discharges of oil in the sea. Illicit discharges are the greatest source of marine pollution from ships, and the one that poses a long-term threat to the marine and coastal environment. Reliable monitoring methodologies and continuously updated comprehensive information are key elements to create effective contingency planning. Satellite monitoring, particularly using synthetic aperture radar (SAR) observations, may represent an effective tool for complementing traditional aerial surveillance. The capability of SAR in detecting oil slicks over the sea surface is well known and recognized, although concerns about reliability, sustainability, and cost effectiveness have inhibited the use of space-borne SAR as an operational and routine monitoring tool. The Joint Research Centre (JRC) is devoted to supporting the operational use of space imagery in case of deliberate oil discharges, as well as during emergencies resulting from large, accidental oil spills. A specific methodology for processing and interpreting a massive set of satellite images has been implemented for the deliberate dumping with the ultimate goal of performing a systematic mapping of illicit vessel discharges at continental scale. The results are stored and organized in a database as the starting point for further focused statistical assessment. This paper presents the methodology implemented to achieve results for the East Mediterranean basin, covering the sea area between Egypt, Greece, and Turkey. The results to date are sufficient to demonstrate how the approach provides a valuable source of information to identify on a solid observational basis the dimension of the operational oil pollution problem. The value of the approach is higher in the areas where routine aerial patrolling is not executed. The activity may become a powerful tool for policy makers to verify the effectiveness of new measures implemented to enhance the protection of the marine ecosystem against deliberate oil pollution.
http://www.srcosmos.gr/srcosmos/generic_pagelet.aspx?pagelet=Article%20summary&pub_id=9844

Second EMCO Workshop: Emerging Contaminants in Wastewaters--Monitoring Tools and Treatment Technologies, 26-27 April 2007, Belgrade, Serbia
FP6 project EMCO, 137 pp, 2007

The second workshop of the European Union (EU)-funded project EMCO (which stands for "reduction of environmental risks, posed by emerging contaminants, through advanced treatment of municipal and industrial wastes") was organized in collaboration with the Faculty of Technology and Metallurgy, Belgrade, Serbia, and Consejo Superior de Investigaciones

Cientificas, Barcelona, Spain. In the course of the workshop, 24 lectures and 24 posters were presented on the principal topic of analysis of emerging contaminants in wastewaters, including toxicity issues, occurrence of emerging contaminants, and treatment technologies. Without appropriate tools, it will not be possible to investigate the fate and behavior of emerging pollutants at wastewater treatment plants and in receiving waters. Analysis of organic pollutants in wastewater is complicated by the great variety of physico-chemical and toxicological properties of compounds grouped together, such as pharmaceuticals. Treatment technologies presented included membrane bioreactors, ozonation, photocatalysis and photo-Fenton, reverse osmosis and nanofiltration, and sorption technologies.
http://www.cid.csic.es/emco/documenti/proceedings%202.pdf

Selection and Application of Investigative Methods for a Chlorinated Solvent Impacted Karst Aquifer
Kafka, T.K. and D. Graves (GeoSyntec Consultants, Knoxville, TN); P. Zeeb (GeoSyntec Consultants, Boston, MA); D. Wanty (Intensol, LLC, Hingham, MA); S. Sacco (Invensys Inc, Foxboro, MA).
Geological Society of America Abstracts with Programs, Vol. 38, No. 3, p. 12, 2006

The authors conducted a hydrogeologic investigation of the karst Knox Group dolomite aquifer in East Tennessee to evaluate deep bedrock groundwater contaminated by chlorinated solvents (cVOC). The investigation focused on how porosity influences groundwater quality, flow, and contaminant transport. Using wire line coring, eight core holes were made in the bedrock to depths of up to 176 feet to collect water samples and assess lithology and integrity. A ColorTec Ground-Water Tester was used to provide real-time semi-quantitative dissolved cVOC concentrations, which were used to assess the presence of DNAPL, the potential for vertical contaminant transport, and the need for a temporary seal over the core holes. Samples were also taken to establish vertical cVOC profiles for each core hole, bedrock structure and lithology was evaluated at four of the holes, and vertical flow, fluid temperature, and resistivity data were also collected. These tools and analyses maximized the site evaluation process, minimized cross contamination, and provided sufficient data for the installation of seven multi-level Water FLUTe monitoring wells.

A Sensitive Chemiluminescence Method for Determination of Hydroquinone and Catechol
Zhao, L., B. Lu, H. Yuan, Z. Zhou, and D. Xiao.
Sensors, Vol 7 No 4, p 578-588, 2007

A novel flow-injection chemiluminescence (CL) method has been developed for the determination of hydroquinone and catechol, based on their inhibition of the CL reaction of luminal/KMnO4/beta-cyclodextrin (beta-CD). Beta-cyclodextrin was found to enhance the CL produced from the reaction of luminol with KMnO4 in basic media. The proposed method is simple, rapid, convenient, and sensitive, and has a linear range of 1 to 20 ng/mL for catechol with a detection limit of 0.4 ng/mL, and 1 to 10 ng/mL for hydroquinone with a detection limit of 0.1 ng/mL. The possible mechanism of the CL reaction is also discussed.
http://www.mdpi.net/sensors/list07.htm

Sequential Extraction Results and Mineralogy of Mine Waste and Stream Sediments Associated With Metal Mines in Vermont, Maine, and New Zealand
Piatak, N.M., R.R. Seal, R.F. Sanzolone, P.J. Lamothe, A. Brown, and M. Adams.
USGS Open-File Report 2007-1063

The USGS is reporting results from sequential extraction experiments and the quantitative mineralogy for samples of stream sediments and mine wastes collected from metal mines. Samples were from the Elizabeth, Ely Copper, and Pike Hill Copper mines in Vermont, the Callahan Mine in Maine, and the Martha Mine in New Zealand. The extraction technique targeted the following operationally defined fractions and solid-phase forms: (1) soluble, adsorbed, and exchangeable fractions; (2) carbonates; (3) organic material; (4) amorphous iron- and aluminum-hydroxides and crystalline manganese-oxides; (5) crystalline iron-oxides; (6) sulfides and selenides; and (7) residual material. For most elements, the sum of an element from all extractions steps correlated well with the original unleached concentration. Also, the quantitative mineralogy of the original material compared to that of the residues from two extraction steps gave insight into the effectiveness of reagents at dissolving targeted phases. The data are presented here with minimal interpretation or discussion; further analyses and interpretation will be presented elsewhere.
http://pubs.usgs.gov/of/2007/1063/

A Simple Pore Water Hydrogen Diffusion Syringe Sampler
Vroblesky, Don A., Francis H. Chapelle, and Paul M. Bradley.
Ground Water, Vol 45 No 6, p 798-802, 2007

Molecular hydrogen (H2) is an important intermediate product and electron donor in microbial metabolism. Concentrations of dissolved H2 are often diagnostic of the predominant terminal electron-accepting processes in groundwater systems or aquatic sediments. This paper describes the design and development (including laboratory and field testing) of a simple, syringe-based H2 sampler in (1) saturated, riparian sediments, (2) surface water bed sediments, and (3) packed intervals of a fractured bedrock borehole. These test sites are inaccessible by standard pumped methods.

Simulated Effects of Soil Temperature and Salinity on Capacitance Sensor Measurements
Schwank, Mike and Timothy R. Green.
Sensors, Vol 7 No 4, p 548-577, 2007

Dielectric measurement techniques are used widely for estimation of water content in environmental media, but readings affected by temperature and salinity require further quantitative investigation and explanation. Theoretical sensitivities of capacitance sensors to liquid salinity and temperature of porous media were derived and computed using a revised electrical circuit analogue model in conjunction with a dielectric mixing model and a finite element model of Maxwell's equation to compute electrical field distributions. The mixing model estimates the bulk effective complex permittivities of solid/water/air media. The real part of the permittivity values were used in electric field simulations, from which different components of capacitance were calculated via numerical integration for input to the electrical circuit analog. Circuit resistances representing the dielectric losses were calculated from the complex permittivity of the bulk soil and from the modeled fields. Resonant frequencies from the circuit

analog were used to update frequency-dependent variables in an iterative manner. Simulated resonant frequencies of the capacitance sensor display sensitivities to both temperature and salinity. The gradients in normalized frequency with temperature ranged from negative to positive values as salinity increased from 0 to 10 g/L. The model development and analyses improved understanding of processes affecting the temperature and salinity sensitivities of capacitance sensors in general. This study provides a foundation for further work on inference of soil water content under field conditions.
http://www.mdpi.net/sensors/list07.htm

Simultaneous Voltammetry Determination of Dihydroxybenzene Isomers by Poly-bromophenol Blue/Carbon Nanotubes Composite Modified Electrode
Pinghua Yang Æ Wanzhi Wei Æ Chunyuan Tao Æ Jinxiang Zeng
2007

A novel modified electrode was constructed by electropolymerization of bromophenol blue at a glassy carbon electrode modified by multiwalled carbon nanotubes. The electrode was used for the simultaneous determination of the isomers of dihydroxybenzene in environmental samples using a voltammetry method. There was a linear relationship over the range 10(-6) to 10(-4) mol/L of hydroquinone, catechol, and resorcinol; the detection limits was 3 x 10(-7) mol/L. The constructed electrode showed excellent reproducibility and stability. Actual water samples were analyzed and satisfactory result was obtained.
http://www.aseanenvironment.info/Abstract/41015931.pdf

Source-Zone Characterization of a Chlorinated-Solvent Contaminated Superfund Site in Tucson, AZ
Brusseau, M.L., N.T. Nelson, Z. Zhang, J.E. Blue, J. Rohrer, and T. Allen.
Journal of Contaminant Hydrology, Vol 90 Nos 1-2, p 21-40, 2007

An extensive site characterization project was conducted at a large Superfund site in Tucson, Arizona, affected by chlorinated solvents. The project consisted of several components, including traditional site characterization activities, tracer tests, laboratory experiments conducted with site samples, and mathematical modeling. This paper describes the analysis of induced-gradient contaminant elution tests conducted in a source zone at the site, investigation of the potential occurrence of immiscible liquid in the saturated zone, characterization of the relationship between mass flux reduction and mass removal, and evaluation of the impact of source-zone management on site remediation. The information generated from this study was used to enhance the site conceptual model, optimize operation of the pump-and-treat system, and evaluate the utility of source-zone remediation.

Spectral Reflectance and Leaf Internal Structure Changes of Barley Plants Due to Phytoextraction of Zinc and Cadmium|
Maruthi Sridhar, B.B., F.X. Han, S.V. Diehl, D.L. Monts, and Y. Su|
International Journal of Remote Sensing v 28 n 5, p 1041-1054, Jan 2007

This paper reports on experiments to use infrared reflectance spectroscopy to provide an indication of heavy metal impact on plants during the process of phytoremediation. Potted barley were subjected to treatments of Zn and Cd. A portable spectroradiometer was used to collect diffuse reflectance spectra (350-2500 nm). Foliar structural changes were seen in the leaves of Zn-treated plants while Cd-treated plants had fewer structural changes. An evaluation of the spectral data revealed that it could not distinguish between the plants treated with different metals a ratio of the 1110 nm band to that at 810 nm correlated closely with the magnitude of leaf structural changes. This study suggests that the infrared reflectance spectrum (800-1300 nm) might provide a non-intrusive monitoring method for the physiological status of plants grown in heavy metal contaminated soil.

Spectroelectrochemical Sensor for Pertechnetate Applicable to Hanford and Other DOE Sites
Heineman, W. R., C. J. Seliskar, and S. A. Bryan
DOE-ERSP PI MEETING: Abstracts, April 16-19, 2007, Lansdowne, Virginia.
U.S. DOE, Environmental Remediation Sciences Program (ERSP). p 47, 2007

The general aim of our work currently funded by DOE is the design and implementation of a new sensor technology that offers unprecedented levels of specificity, needed for analysis of the complex chemical mixtures found at DOE sites nationwide. This project involves a very successful collaboration between scientists at the University of Cincinnati (UC) and several at the Pacific Northwest National Laboratory (PNNL) and the Environmental Molecular Sciences Laboratory (EMSL). The goal of the work is the continued development of a sensor for 99Tc that is applicable for characterizing and monitoring the vadose zone and associated groundwater. The single focus is pertechnetate, TcO4 -, which is considered to be the dominant species in the vadose zone and ground water. The sensor will have the capability for on-site monitoring, either by immersion in subsurface water for continuous monitoring, or for the immediate analysis of collected samples. The project will build on the substantial progress of a well established UC-PNNL collaboration that provides the wide range of expertise needed for success: spectroscopy, electrochemistry, device fabrication, thin film technology, synthetic inorganic chemistry, experience with Tc, and facilities for handling radioactive isotopes. The sensor will consist of an innovative fluorescence-based spectroelectrochemical configuration that we have developed under our previous EMSP grants. The spectroelectrochemical sensor has been demonstrated on a variety of chemical systems, including an authentic tank waste sample from Hanford. The following benchmarks have been met:

Studying the Effect of Deposition Conditions on the Performance and Reliability of MEMS Gas Sensors
Sadek, Khaled and Walied Moussa.
Sensors, Vol 7 No 3, p 319-340, 2007

The reliability of a micro-electro-mechanical system (MEMS)-based gas sensor was investigated using 3-D coupled multiphysics finite-element (FE) analysis. The coupled field analysis involved a two-way sequential electrothermal fields coupling and a one-way sequential thermal/structural fields coupling. An automated substructuring code was developed to reduce the computational cost involved in simulating this complicated coupled multiphysics FE analysis by up to 76%. The substructured multiphysics model then was used to conduct a parametric study of the MEMS-based gas sensor performance in response to the variations expected in the thermal and mechanical characteristics of thin film layers composing the sensing MEMS device

generated at various stages of the microfabrication process. Whenever possible, the appropriate deposition variables were correlated to the design parameters, with good accuracy, for optimum operation conditions of the gas sensor. The design rules derived using linear and nonlinear empirical relations can be used in real time at the design and development decision-making stages of similar gas sensors to enable the microfabrication of reliable sensors.
http://www.mdpi.net/sensors/list07.htm

Subtask 1.15: Passive Diffusion Sample Bags Made from Expanded Polytetrafluoroethylene (ePTFE) to Measure VOC Concentrations in Groundwater
Botnen, Barry W., Energy & Environmental Research Center, Univ. of North Dakota, Grand Forks. DOE Contract No. DE-FC26-98FT40320, 2006-EERC-09-01, 81 pp, 2006

With laboratory testing of expanded polytetrafluoroethylene (ePTFE) membranes complete, collected data support that volatile organic compound (VOC) molecules will readily diffuse across ePTFE membranes. Membrane samples, supplied by BHA Technologies (GE Osmonics), were tested to determine diffusion rates for VOCs in groundwater. Tests were conducted using membranes with two different pore sizes, with and without thermally laminated spun bond backing, and multiple concentrations of contaminated groundwater. Results suggest that typical residence times associated with traditional samplers constructed of polyethylene (2 weeks) can be reduced by 1 week using ePTFE membranes and that VOCs will diffuse more readily at lower temperatures (2.2-3.3 C) across ePTFE materials.
http://www.osti.gov/bridge/product.biblio.jsp?query_id=2&page=0&osti_id=908321

Synthesis, Characterization and Metal Ion Detection of Novel Fluoroionophores Based on Heterocyclic Substituted Alanines
Costa, S.P.G., E. Oliveira, C. Lodeiro, and M.M.M. Raposo.
Sensors, Vol 7 No 10, p 2096-2114, 2007

This paper describes the synthesis of new fluorescent probes containing the thiophene and benzoxazole moieties combined with an alanine residue. The resulting highly fluorescent heterocyclic alanine derivatives respond via a quenching effect with paramagnetic Cu(II) and Ni(II) metal ions and with diamagnetic Hg(II) as shown by absorption and steady-state fluorescence spectroscopy studies. The formation of mononuclear or dinuclear metal complexes was postulated based on the presence of the free carboxylic acid as binding site and also with the interaction with the donor atoms in the chromophore. Interaction with other important biological metal ions, such as Zn(II), Ca(II), and Na(I), was also explored. The synthetic, photophysical, and metal ion-sensing properties displayed by these compounds show that they are promising candidates as fluorescent probes and for potential sensory applications.
http://www.mdpi.net/sensors/list07.htm

A Systematic Data-Driven Approach to Evaluating Hydraulic Capture at Superfund Sites in USEPA Region 5

Cohen, H.A. and M.J. Tonkin (SS Papadopulos & Associates, Bethesda, MD); D. Wilson (U.S. EPA Region 5, Chicago, IL); D.E. Dougherty (Subterranean Research, Inc., Duxbury, MA).

Geological Society of America Abstracts with Programs, Vol 39 No 6, p 18, Paper 2-12, 2007

This presentation focuses on the use of mapping-based techniques to illustrate the likely extent of hydraulic capture by pump-and-treat systems. The extent of groundwater contaminated above cleanup levels by target contaminants is mapped as a composite target zone (CTZ). The CTZ is based upon the upper 95% confidence limit of recent measurements for each contaminant at each monitoring point as calculated using the PAM intrawell statistical analysis software developed by Subterranean Research. These methods require data for water levels, contaminant concentrations, and pumping rates that can be rapidly manipulated, evaluated for quality control, and summarized into discrete data sets. The mapping uses universal kriging, embedding equations that describe the response of the potentiometric surface to extraction or injection wells and discharge to/from surface water bodies. Particle tracking is used with the mapped surface(s) to approximate capture zones. If a groundwater flow model is available, related mapping techniques can be used to incorporate simulation results as a trend or 'drift.' Automation of database queries, kriging, and particle-tracking routines enables relatively rapid evaluation of hydraulic capture at multiple time periods. Dozens of discrete time-period maps can be evaluated simultaneously to develop capture-probability maps. The efficiency and cost-effectiveness of the analyses is dependent upon data standardization and quality review. While automation of mapping can be effective, it cannot replace the need for thoughtful assessment of the site. For example, analyses can reveal significant concerns unrelated to hydraulic capture, such as conflicts between proposed treatment technologies and the groundwater redox conditions, or capture-related concerns such as inadequate pumping rate data or inappropriate monitoring well locations.

Trace Metal and Stable Isotope Characterization of Low-Flow Acid Mine Drainage (AMD) Seeps in Indiana

Reeder, Matthew (Indiana Univ., Bloomington); Tracy Branam (Indiana Geological Survey, Bloomington); Lisa Pratt (Indiana Univ.).

Geological Society of America Abstracts with Programs, Vol 39 No 6, p 405, Paper 145-9, 2007

Three abandoned coal mining sites in southwest Indiana are being considered for the installation of passive remediation systems. At each site, acidified ($pH < 2$ or 3) seeps will be treated in a constructed sulfate-reducing bioreactor cell (SRBC) consisting of well-mixed compost, straw, and limestone gravel. The pre-existing conditions at each of the sites prior to construction of the treatment systems are being characterized. Analysis of the delta S-34 (sulfate, sulfide, and elemental sulfur) and delta O-18 (water and sulfate) will be used in combination with vadose-zone hydrology and trace metal chemistry data to identify the contribution of sulfate from precipitation interacting separately with mine tailings and spoils before mixing and eventually discharging at the seeps. The rate and extent of microbial activity related to sulfate generation also will be resolved from this information. These data will allow engineers to determine the size of bioreactor cell needed to achieve a specified effective lifespan before the useful capacity of the cell is exceeded. For comparison purposes, a constructed wetland built in 2004 to contain runoff from a mine tailings pile will be monitored using the same methods.

Preliminary results indicate that the wetland may be behaving like an SRBC in terms of alkalinity generation and decreasing trace metal concentrations. The characteristics and environmental impact of acid mine drainage (AMD) seeps at these sites are similar to those of other sites in the Midwest and will provide information applicable to low-flow AMD discharges throughout the region.

U.S. Geological Survey Field Leach Test for Assessing Water Reactivity and Leaching Potential of Mine Wastes, Soils, and Other Geologic and Environmental Materials
Hageman, Philip L.
U.S. Geological Survey Techniques and Methods 5-D3, 13 pp, 2007

The U. S. Geological Survey (USGS) has developed a fast (5-minute), effective, simple, and cost-effective leach test that can be used to simulate the reactions that occur when materials are leached by water. The USGS Field Leach Test has been used to predict, assess, and characterize the geochemical interactions between water and a broad variety of geologic and environmental matrices. Examples of some of the samples leached include metal mine wastes, various types of dusts, biosolids (processed sewage sludge), flood and wetland sediments, volcanic ash, forest-fire burned soils, and many other diverse matrices. The Field Leach Test has been an integral part of these investigations and has demonstrated its value as a geochemical characterization tool. It has enabled investigators to identify which constituents are water reactive, soluble, mobilized, and made bioaccessible because of leaching by water, and to understand potential impacts of these interactions on the surrounding environment.
http://pubs.usgs.gov/tm/2007/05D03/

Use Dendrochronological and Dendrochemical Methods for Dating Hydrocarbon Contamination of the Saint-François and Massawippi Riverbanks
St-Laurent, J., D. Saint-Laurent, and P. Duplessis (Univ. du Quebec a Trois-Rivieres); J. Marion (INRS-ETE, QC, Canada).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Sediments contaminated with hydrocarbons (C10 through C50) were discovered recently in the banks of the Saint-Francois and Massawippi rivers. Researchers aimed to determine the spatial distribution of the contamination along the banks of these rivers and to date the contamination period using dendrochronological and dendrochemical methods. Five core samples were taken from a red ash (Fraxinus pennsylvanica Marsh.) at Windsor Station and twelve core samples were selected at Richmond station, where the level of hydrocarbon contamination in the sediments is among the highest. Dendrochemical analyses were done on the tree rings. Dendrochemistry was used to determine that there were heavy metals in the rings. Soil materials were used to evaluate the concentrations of heavy metals (i.e., As, Cd, Cu, Pb, and Zn) and ratio-isotope analyses (204Pb/206Pb, 207Pb/206Pb, and 208Pb/206Pb). The total lead concentration in the tree rings increased drastically around 1958 due to the absorption of lead from the sediments that may have been contaminated by hydrocarbons around this date. The total lead concentration in Richmond trees (F. pennsylvanica Marsh.) are very high compared to those at the Windsor station.

Use of a Collaborative Dataset to Enhance Data Representativeness

Burkhardt, L. (Raytheon, Sudbury, MA); R.J. Fiacco, Jr., M. Ravella, M. Duquoc, C. Coladonato, J. Mark, and E.J. Moore (ERM, Boston, MA)

The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Effective characterization of chlorinated solvent sites in glaciated terrains presents technical challenges. The highly heterogeneous nature of stratified glacial sedimentary deposits results in complex distribution of chlorinated volatile organic compounds (CVOCs) within source zones and associated dissolved-phase plumes. Typically, source zones consist of residual dense nonaqueous-phase liquid (DNAPL), diffused CVOCs, and/or sorbed CVOCs located in relatively low permeability zones. In some cases, these zones of relatively low permeability are obvious silt or clay layers, but in many other cases they are indiscernibly finer-grained sand lenses that can be difficult to locate. Dissolved-phase CVOC plumes emanating from these source areas typically exhibit the general dimensions of the source area, due to minimal transverse dispersivity, and migrate within zones of relatively high permeability. Cost-effective characterization of CVOC sites in glaciated terrains requires an innovative approach, such as the Triad approach, which is characterized by systematic project planning, dynamic work strategies, and real-time measurement technologies. A Triad investigation was conducted at a complex site in eastern Massachusetts. A collaborative dataset was generated using the membrane interface probe, modified Waterloo Profiler, and traditional monitoring wells. Collectively, these data were used to define a series of chlorinated solvent source areas and plumes at the site. Relative to earlier investigations, development of a collaborative data set significantly reduced uncertainty associated with the site.

Use of Borehole Geophysical Logging, Packer Testing, and Discrete Groundwater Sampling in Assessment and Remediation of a Release of #2 Fuel Oil at a Western Massachusetts Residence

Garretson, J.W., G.A. Brown, and M. Carnevale.

The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

A release of more than 250 gallons of #2 fuel oil at a Western Massachusetts residence was discovered in April 2006. The release appeared to be attributable to a leaking fuel oil storage tank line beneath the concrete floor. The released fuel oil entered bedrock fractures beneath the residence and impacted 150- and 250-foot deep bedrock drinking water wells at the subject site and at an adjacent residence. To determine the extent of petroleum impacts in bedrock, borehole geophysical logging was performed on the two impacted wells to characterize bedrock fractures in the wells. Equipment used included a borehole diameter caliper probe; formation resistivity, single point resistance, and spontaneous potential electric probes; a natural gamma radiation probe; fluid temperature and resistivity probes; an acoustic televiewer probe; and a heat pulse flow meter probe (under both ambient and stressed conditions). The geophysical results provided data on bedrock fracture size, depth, orientation, and conductivity. Based on the data, packer testing was performed to provide additional information on fracture conductivity and to allow collection of groundwater samples from discrete depths. The geophysical, hydrologic, and chemical data subsequently were used to develop a bedrock assessment program that included installation, evaluation, and monitoring of five additional bedrock wells located to intercept the more heavily impacted fractures. Data from all bedrock wells were subsequently used to design and implement systems for both groundwater recovery and ex situ treatment and in situ soil and groundwater treatment via chemical oxidation (Fenton's Reagent).

Use of XRF to Characterize Mine Waste Sediment in a Marine Environment
Calicchio, W.D., P. Baker, T. Cunningham, and C. Ricardi, MACTEC, Inc., Portland, ME.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

X-ray fluorescence (XRF) was used for metals analysis of estuarine sediment samples collected to delineate lateral and vertical extent of contamination in support of a remedial investigation/feasibility study (RI/FS) to complete a record of decision (ROD) at a former copper, lead, and zinc sulfide ore mine site on the coast of Maine. During a 15-day period, 537 samples were collected and analyzed by on-site XRF. Sufficient sediment volume was collected to fill soil jars. Aliquot was prepped and analyzed in accordance with EPA Method 6200. Remaining original sample was archived. Thirty-seven sediment samples (7%) were submitted to a contracted commercial laboratory for metals analysis by EPA Method 6010B (ICP)/6020 (ICP-MS). Metal concentrations for Sb, As, Ba, Cd, Cr, Co, Cu, Pb, Mn, Hg, Ni, Se, Ag, Tl, and Zn reported by the commercial laboratory were compared to on-site XRF concentrations to determine precision, accuracy, and bias of XRF data. Average relative percent differences (RPDs) between XRF and commercial laboratory results ranged from 24 to 68 for Cu (24), Pb (58), Zn (37), As (68), and Mn (35), indicating good comparability. Ba (192), Cd (91), and Cr (196) had high average RPDs. A general trend of higher concentrations reported by XRF was observed, indicating possible high bias. Of the 176 calculated RPDs, 70 exceeded 50 (EPA Region I guidelines comparing solid matrices field duplicates). Statistical analysis of variance and comparison of RPDs to grain size analyses were reviewed to determine usability of data and effects on XRF quantitation of metals in sediment. Overall agreement was observed using XRF analysis supported by commercial laboratory confirmation. The XRF was shown to be an effective, cost-saving instrument to support contamination assessments of Cu, Pb, and Zn in sediments at the coastal former mine site.

Using Direct-Push Tools to Map Hydrostratigraphy and Predict MTBE Plume Diving
Wilson, John T., Randall R. Ross, and Steven Acree.
Ground Water Monitoring & Remediation,
Volume 25 Issue 3 Page 93-102, Summer 2005

Two site characterization techniques, electrical conductivity logging and pneumatic slug testing, were used to predict the extent of ground water contamination from a MTBE plume in an aquifer that supplies water to the village of East Alton, Illinois. After staying near the water table, the plume dived below conventional monitoring over 200 m from the potential source of contamination at a depth to water of 9.1 m below land surface. Electrical conductivity logging indicated that the silts and clays comprised the first 10 m of material below the water table, and also detected sand and gravel from 10.6m to 15.2 m below the water table. Pneumatic slug tests indicated higher hydraulic conductivity (12.5, 11.6, and 11.3 m/d) in the sand and gravel interval than in the silt and clay interval (0.34 and 0.012 m/d). Ground water with the highest MTBE concentrations was found in the interface between the two intervals.

Using Naturally Occurring Radon as a Tracer for Vapor Intrusion: A Case Study
Wisbeck, D., C. Sharpe, A. Frizzell, C. Lutes, and N. Weinberg, ARCADIS.
Society For Risk Analysis Annual Meeting, 2006

The empirical characterization of vapor intrusion (VI) inside potentially impacted buildings is complicated by the cost of collecting VOC samples, the interpretation of VOC data (which is often biased by background sources of VOCs), and the wide range of physical/chemical factors that influence VI. Given these potential interferences, the measurement of naturally occurring radon in sub-slab soils and indoor air provides a cost-effective, rapid means of evaluating VI through the use of attenuation factors. Generally, the indoor radon concentration varies according to the ratio of soil gas infiltration to indoor air exchange rate. Radon provides a unique tracer for vapor intrusion because in the indoor environment, its presence is usually a result of radon in soil gas. In addition, the entry mechanisms to indoor air are believed to be the same for VOCs and radon. The following advantages of using radon as a tracer for VI characterization are noted. (1) Measurement of radon is easier and less expensive than for VOCs and less subject to interferences. (2) A site-wide passive radon "reconnaissance" can quickly identify locations likely to warrant early VI investigation and mitigation. (3) Hot spots can be evaluated quickly to estimate potential infiltration problems. (4) Use of radon sampling data may help reduce the potential for tort liability concerns as radon is a naturally occurring gas. This presentation discusses the pros and cons of radon sampling as a surrogate for VOC analysis and provides specific data from a case study at a manufacturing site.

Using NMR Decay-Time Measurements to Monitor and Characterize DNAPL and Moisture in Subsurface Porous Media
Hertzog, Russel C. and Timothy A. White (Idaho National Laboratory, Idaho Falls); Christian Straley (Schlumberger Doll Research Laboratory, Ridgefield, CT).
Journal of Environmental & Engineering Geophysics, Vol 12 No 4, p 293-306, Dec 2007

The capability and limitations of low-field proton nuclear magnetic resonance (NMR) relaxation decay-rate measurements were investigated for determining environmental properties affecting DNAPL solvent flow in the subsurface. This paper describes how NMR measurement techniques can be used to characterize, monitor, and evaluate the dynamics of mixed fluids (water/DNAPL) in unconsolidated near-surface porous environments. It also discusses the use of proton NMR T2 (spin-spin relaxation time) measurements to identify and characterize the presence of DNAPL in unconsolidated sandy soil samples. The potential of NMR decay-rate distributions for characterizing DNAPL fluids in the subsurface and understanding their flow mechanisms has not previously been exploited.

Utilizing LNAPL Laboratory Testing Methods to Evaluate Mobility for Site Characterization & Selection of Remedial Alternatives
Fagan, B.J. (Haley & Aldrich, Inc., Boston, MA); M. Brady (PTS Laboratories, Inc., Santa Fe Springs, CA).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Conventional methods and modeling for the potential mobility of LNAPL for petroleum impacted site assessment has relied heavily on indirect indicators of LNAPL plume stability and mobility in soil gathered from well information, fractional concentration of organics in soil characterized with EPA methods, saturation profile modeling, and other indicators. This presentation reviews lab test alternatives under consideration for direct quantification of LNAPL mobility in soil coupled with lines of evidence for the site, ranging from comparison of field saturation relationships to residual saturation capacities of the soil to methods to more direct methods (e.g., capillary pressure drainage relationships, analysis of the relative permeability of the LNAPL to flow in soil in the presence of groundwater, and methods for measurement using unsteady state constant flow testing and water flood pore volume exchange methods) to quantify LNAPL drainage and imbibition. Methods of analysis such as these reinforce field observations and develop the understanding of the migration potential of a plume source and boundaries with more direct quantitative procedures to support risk-based approaches for land reuse. For feasibility analysis of site treatment, they can be instrumental in quantifying the potential performance of a remedial technology for LNAPL containment and recovery, as well as for evaluation of the impacts of amendment and thermal modifications to LNAPL.

Validation of Rapid Dioxin Screening by GC-FID in Fish Products
Bassompierre, M., L. Munck, R. Bro, G. Tomasi, and S.B. Engelsen.
Dioxin 2004: 24th International Symposium on Halogenated Persistent Organic Pollutants, Organohalogen Compounds, Vol 66, p 302-309, 2004

A novel, cost- and time-effective dioxin screening method was developed and validated for fish products. The method is based on multivariate covariance between fatty acid composition monitored by GC-FID and dioxin content as teq WHO pg/ g fat. A dioxin range varying from 1.1 to 47.1 pg TEQ-WHO/ g fat using 65 fish meal samples was accessible for model calibration. An optimal multivariate dioxin prediction model was developed based on automatic peak integration, thereby enabling extraction of the area of 140 peaks from the gas chromatograms. Models were produced employing partial least squares regression (PLS) based upon the duplicate GC-FID run and 46 specific peaks, selected after variable selection from the 140 investigated. The best results were yielded by local PLS modeling employing three latent variables based upon the 12 nearest neighbors. For each prediction sample, the neighbors yielding the 12 smallest sum of squares of differences to the test sample using the 140 peaks were extracted from the whole calibration set, and a local model was built using these 12 chromatograms and related dioxin content. Prediction performance was thereafter validated for 10 fully independent samples. The performance of this model, yielded a correlation of 0.85 (r2) and a root mean square error of prediction of 2.3 pg PCDD/F TEQWHO/g fat.
http://dioxin2004.abstract-management.de/pdf/p78.pdf

The Value of Characterizing the Hyporheic Zone at a Variety of Contaminant Sites
Emmons, M. (Resource Laboratories, LLC, Portsmouth, NH); R.S. Behr, T. Smith, and B. Beneski (Maine Department of Environmental Protection, Station 17, Augusta, ME).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

In New England, groundwater discharges often manifest themselves as distinct springs or as wetlands adjacent to a stream or river, while in other instances the groundwater may discharge directly to the stream through the underlying sediments. This zone of discharging groundwater is called the hyporheic zone. Characterizing the chemistry of this discharging water provides useful information about upgradient contaminant sources and impacts to surface water bodies. Using a push-point(tm) sampler, an inexpensive sampling device, the chemistry of discharging groundwater can be assessed. Hyporheic zone characterization data from two contaminant sites are presented to illustrate the usefulness of these data in a site investigation. For example, data from characterization of the hyporheic zone can provide invaluable data about upgradient groundwater quality before installation and sampling of monitoring wells. Evaluation of the hyporheic zone also can optimize subsequent monitoring well placement, as when groundwater data from a small network of bedrock monitoring wells demonstrated the existence of a contaminant plume associated with a sludge-filled quarry, but limited funds precluded the downgradient delineation with additional bedrock wells. Subsequent chemical characterization of the hyporheic zone along a small brook at the site identified groundwater discharges more 1,200 feet from the source. Historically, investigators have largely relied on surface water samples to assess the impact of discharging contaminant plumes; however, characterization of the hyporheic zone may reveal that the biota residing in the stream sediments are exposed to a very different chemical environment. Data are presented from sites where the hyporheic zone water quality data clearly demonstrate that surface water chemistry differs from the chemical environment within stream sediments, the portion of the stream in which benthic organisms live.

Vapor Intrusion Investigations Utilizing Passive Soil Gas Sampling.
Whetzel, J., H. Anderson, and J. Hodny, W.L. Gore and Associates, Inc., Elkton, MD.
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Recent state and advisory group guidance documents provide good overviews of the investigative process and of the techniques available for investigating the vapor intrusion (VI) pathway. Passive soil gas (PSG) sampling is a versatile tool that can be used to screen sites for the presence of potential chemicals of concern, to map subsurface soil gas plumes, and to focus subsequent sampling by more complex and costly methods. Advantages of PSG sampling include simple and quick installation and retrieval, the ability to collect soil gas in low-permeability/high-moisture soils, time-integrated sampling, and the ability to detect a broad range of chemicals at low concentrations. Although PSG sampling data often are reported in units of relative mass levels, recent laboratory and field studies have been performed to examine the technique as a tool to estimate soil gas concentrations. Providing soil gas concentrations improves the ability of the technique to focus subsequent sampling and to screen sites for potential vapor intrusion risk. This presentation will include a description of a PSG sampling tool, the GORE(tm) Module; describe the calculations used to determine concentrations; include a summary of laboratory study results; discuss how PSG sampling data are used in VI investigations; and present examples of field studies and investigations that incorporate estimated concentration values.

A Vapor Intrusion Study Using Multiple Lines of Evidence
Weaver, C.J. and P.J. Bovitz (Weston Solutions Inc., Edison, NJ); J.T. Moore (U.S. Army Corps of Engineers, East Brunswick, NJ); J.A. Kelly (U.S. Army Corps of Engineers, Concord, MA).
The 23rd Annual International Conference on Contaminated Soils, Sediments and Water, 15-18 October 2007, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. Abstracts, 2007

Fifty-eight buildings located over six groundwater plumes at the Former Raritan Arsenal in Edison, NJ, have been evaluated to determine if VOC-contaminated groundwater is affecting indoor air quality. In the absence of state regulatory guidance, USACE initially developed its own methodology for evaluating risks under CERCLA, including site-specific risk-based non-residential criteria. The vapor intrusion pathway subsequently was assessed in accordance with the New Jersey Department of Environmental Protection (NJDEP) vapor intrusion guidance (VIG) beginning in 2004. Initial screening criteria (e.g., presence of buildings within 100 feet of the delineated groundwater plume boundary) were used to determine what buildings required investigation. Subsequent investigations included sampling subslab soil gas, soil, and indoor and ambient air concentrations of VOCs. A weight-of-evidence approach was used to determine whether further action was required, based on (1) exceedances of residential VIG benchmarks in subslab soil gas and indoor air; (2) evaluation of individual constituents as potential DoD-related contaminants; (3) comparison of indoor air concentrations with background ambient air concentrations; (4) comparison of concentrations of VOCs in groundwater, subslab soil gas and indoor air; and (5) replicability of sampling results and consistency of ratios of VOC concentrations in groundwater, subslab soil gas, and indoor air. The NJDEP has concurred that over 40 buildings require no further action. Twenty buildings require ongoing monitoring and investigations, of which 10 have had remedial systems installed to address vapor intrusion. Where systems have been installed, USACE has followed its own risk-based criteria, consistent with CERCLA.

Variability Associated with Multi-Increment Soil Sampling: Implications for Risk Assessment
Ryti, R., J. Linville, J. Markwiese, S. Weiss, and J. Thompson.
Society for Risk Analysis Annual Meeting, 2006

Multi-increment sampling (MIS) provides results for the average concentrations of contaminants across an investigation area. The concept behind MIS is that the particle size and decision units are defined. MIS has been applied to contaminated areas at the Hanford Site in Washington State. Five MIS samples were collected from each waste site to provide a measure of the variability between samples. The investigators evaluated the variability in the soil contaminant concentrations for a given number of soil increments (each MIS comprised 50 increments) and assessed the results versus possible risk-based soil cleanup levels. The variability of contaminant concentrations from MIS sampling was generally low, with some exceptions (e.g., lead at one debris site). The results of MIS to grab samples collected at the same sites were compared, and the Visual Sampling Plan Version 4.0a software was used to evaluate the statistical performance of sampling design options. The authors also review the overall performance of MIS and make recommendations on its applicability to risk assessment projects.

Visual Methods for Geochemical Screening of Possible Impacts to Groundwater by Oilfield Brines
Lee, R.S., D.T. Adamson, and M. Vanderford, GSI Environmental, Inc.
14th Annual International Petroleum Environmental Conference, 6-9 November 2007, Houston, Texas. 17 pp, 2007

Because the primary components of oilfield brines (sodium and chloride) occur in groundwater naturally and also may come from other contaminant sources, sodium and chloride content alone are not reliable indicators of possible low-level oilfield brine impacts. Graphical methods used to evaluate chemical characteristics facilitate comparison of groups of samples (e.g., groundwater and brine) based on relative proportions of multiple ions. A recent investigation in Texas used histograms, Piper plots, and Stiff diagrams to compare visually major ion content of well water with suspected brine impacts to produced water from a nearby oilfield, as well as to regional groundwater chemistry from a published database. Graphical comparison showed allegedly impacted well water to be geochemically distinct from oilfield brine and similar to regional groundwater quality. To demonstrate a complementary approach, the data from the Texas study were re-analyzed using cluster analysis, which combines multivariate statistics with simple graphics to aid interpretation of the similarities among multiple variables. Samples are clustered with similarity expressed as a simple percentage displayed on a single dendrogram plot, facilitating visual discernment of similarities or differences among multiple samples without the need to compare numerous individual plots. Re-analysis of the Texas data provides an additional line of evidence to support the conclusion that well water chemistry is not the result of anthropogenic brine impacts.
http://ipec.utulsa.edu/Conf2007/2007agenda.html

Small Business Innovation Research (SBIR) and Other Grants

National Science Foundation

Allosteric DNAzyme Sensors for Practical Detection of Cyanotoxins (NSF 2007 STTR Phase 1)
Juewen Liu,PI, 217/377-9806; jliu2@uiuc.edu
DzymeTech Inc., Champaign, IL 61820; Partnered with the University of Illinois
NSF Award Number: 0711622
$149,995
July 1, 2007 - June 30, 2008

This STTR Phase I research will develop detection methods using allosteric DNAzymes (aptazymes) to detect cyanobacterial toxins that occur throughout the world in both fresh and brackish water. Cyanotoxins present a public safety hazard through contamination of drinking water supplies by blue-green algae (cyanobacteria), and sensitive detection of cyanotoxins has been a long-standing challenge. Although instrumented and immunological methods have been developed, a fast and accurate detection kit with high sensitivity and selectivity is still not available and its development would be very desirable. DzymeTech Inc. and the laboratories at the University of Illinois have previously developed many functional DNA-based sensors for metal ions and small molecules, such as cocaine. In this research, a related combinatorial selection method will be used to obtain DNAzymes that are allosterically activated by cyanobacterial toxins. By attaching fluorophore-quencher pairs or gold nanoparticles to the DNA, practical sensors that target cyanobacterial toxins will be generated.

A New Method for Quantitative Calibration-Free Chemical Analysis (NSF 2007 SBIR Phase 1)
Arel Weisberg, PI, aweisberg@er-co.com
Energy Research Company, Staten Island, NY 10309 718/608-8788
NSF Award Number: 0740542
$99,999
Jan 1, 2008 - June 30, 2008

The Small Business Innovation Research (SBIR) Phase I project involves development of Analytical Laser Induced Breakdown Spectroscopy (LIIBS), a breakthrough method of material analysis that will allow for heretofore unattainable process control capabilities in metal and glass production. This research will result in new plant instruments capable of rapidly measuring materials' chemical composition, a major factor in metal and glass quality. The proposed Phase I research will include development of a new method to accurately measure key physical constants of important chemical elements in metal and glass production. Insights into the fundamental physics of this measurement method will be gained, as well as new mathematical techniques to compute material compositions. The proposed activity will impact manufacturing plants that produce glass, metal alloys, and other materials by allowing plant personnel to continuously monitor the composition, and thereby the quality, of their material for the first time. Increased plant output, reduced waste, and reduced energy use will result from optimizing the plant operation. There will also be benefits in other fields that that can utilize the on-site measurement technique; including the environment, planetary science, agriculture and food science, and explosives detection and other security applications.

Novel High Performance, Low Cost Gas Sensor Platform (NSF 2007 SBIR Phase 1)
Luke Ferguson, PI, 425/347-0919; luke@thickfilmtech.com
Thick Film Technologies, Inc., Everett, WA 98204
NSF Award Number: 0711697
$99,331
July 1, 2007 - March 31, 2008

This Small Business Innovation Research (SBIR) Phase 1 research project will optimize novel thick film materials and low cost screen-printing processes to create high performance, selective gas sensors that are significantly less expensive than competing technologies. Currently there are no stable, rapid responding semiconductor gas sensors that exhibit improved selectivity and that are inexpensive to manufacture. This research intends to solve this problem by demonstrating that high performance sensor platforms can be fabricated using well-developed, inexpensive screen-printing techniques and its proprietary NanoCarbon thermally fugitive ink systems. Advanced low-thermal mass platforms will be created that enable robust gas sensors to respond rapidly, use very little power, and achieve improved selectivity and stability through temperature-programmed modulation. These innovative high performance gas sensors could have important broad impacts on the environment, health, safety and energy conservation. Specific examples of health and safety benefits include rapid detection of dangerous flammable and toxic gases, and low-cost portable sensors for detection of chemical warfare agents.

Novel MEMS Pressure Sensor (NSF 2007 SBIR Phase 1)
Todd Hochwitz, PI, hochwitz@technical-mandala.com
Wyoming Silicon, LLC, Sheridan, WY 82801 307/752-2615
NSF Award Number: 0740424
$100,000
Jan 1, 2008 - June 30, 2008

This Small Business Innovation Research Phase 1 research project will develop a novel MEMS capacitive pressure sensor that can be used for making highly accurate water depth measurements. Intended for use in regulated, long-term, unattended environmental monitoring of groundwater, the device will meet or exceed stringent federal and state regulations requiring an accuracy of at least 0.01 foot to a depth of 500 feet, or 0.002% of full-scale reading. This project involves the study of at least three MEMS device geometries, embodying designs that provide either redundancy or multiple pressure measurement ranges. In addition, at least two electronic circuit topologies will be studied for suitability in interfacing with existing commercial devices. The inherent non-linear behavior of the device will pose significant challenges in both areas; however, the non-linear characteristic of the sensor yields a large dynamic range of operation, which is highly desirable for this target application. The commercial merits of this project have immediate utility in the target market of environmental monitoring of groundwater. Improved monitoring of groundwater has clear societal benefits. Accurately predicting where contaminants might flow requires precise modeling of water percolation, aquifers, and surface water flow. A low-power sensor will allow for the deployment of entire networks for monitoring groundwater behavior more precisely over a greater distance with a faster measurement rate than current technologies. Providing a physically small device will enable the use of low-cost, small-diameter boreholes for underground monitoring, reducing installation costs.

Optical Mode Conversion for Chemical and Biological Sensing and Analysis (NSF 2007 SBIR Phase 1)
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Senspex, Inc., Rio Rancho, NM 87124 505/891-0034
NSF Award Number: 0741073
$99,999
Jan 1, 2008 - June 30, 2008

This Small Business Innovation Phase I research project proposes a novel diagnostic tool based upon evanescent field and complementary molecular vibrational spectroscopy methods for rapid detection and analysis of hazardous biological and chemical targets in solution and air. The main characteristic of the proposed approach is the use of evanescent field Surface Enhanced Raman Spectroscopy (SERS) and an active integrating probe with maximized evanescent field of propagating excitation signal created by controlled optical mode shifting in the active sensor region. The investigators propose to develop designs and fabrication methods for planar waveguide mechanisms to reversibly and controllably transfer photonic energy between optical modes within a specified path length. The sensor element will be attached to a Raman identification system to obtain Raman and fluorescence signals. The evanescent field at the sensor-environment interface will interact with biological and chemical molecules adsorbed onto or near the surface. Potential commercial applications of the proposed sensor system for environmental contamination include the possibility of contamination level observation in a large variety of remote locations by the use of fiber optic transmission or wireless network of sensor signals to analytical hardware; development of real-time monitoring equipment for hazardous industrial environments; detection of toxic industrial chemicals spills in commercial/industrial chemical storage and transport locations; and development of real-time scanning systems for tap water contamination levels in residential and commercial buildings.

Structurally Integrated Organic Light Emitting Device-Based Sensors for Dissolved Oxygen in Water (NSF 2007 SBIR Phase 2)
Ruth Shinar, PI, rshinar@iastate.edu
Integrated Sensor Technologies, Inc., IA 50014, 515/292-4226
NSF Award Number: 0724090
$499,988
Sep 1, 2007 - Aug 31, 2009

This SBIR Phase II project aims to develop and commercialize a novel, next-generation photoluminescence (PL)-based, palm-size, and miniaturizable dissolved oxygen (DO) sensor. DO sensors are primary monitors of water quality in industrial wastewater treatment. The new sensor is based on a pioneering platform for PL-based biochemical sensors where the excitation source is a pulsed organic light emitting device (OLED) pixel array that is structurally integrated with the sensor component. The individually addressable pixels and the sensor film are fabricated on either side of the glass substrate. The photodetector is "behind" the OLED array, monitoring the PL passing between the OLED pixels. This uniquely simple structural integration enables multi-sensor fabrication on a single, compact substrate, and should therefore yield field-deployable micro-sensor arrays for simultaneous detection of various analytes. This sensor has applicability in water quality measurements in wastewater treatment, power, pulp and paper, chemical, food, beverage, brewing, and pharmaceuticals plants, fish farms, fresh water, coastlines, and the oceans. Current sensors suffer from key drawbacks that limit their utility and application. Electrochemical sensors require frequent calibration and maintenance, and are typically slow to respond. PL-based sensors are expensive due to intricate design. The proposed sensor will be reliable, require very little maintenance/calibration, and will be inexpensive, with a flexible design and size.

U.S. Department of Energy

Broadly Tunable Quantum Cascade Laser Technology for Remote Sensing (DOE 2007 STTR Phase 2)
Dr. John Barry McManus, PI, 978-663-9500; mcmanus@aerodyne.com
Aerodyne Research, Inc., Billerica, MA 01821-3976; www.aerodyne.com; Partnered with Rice University, Houston, TX
DOE Grant No. DE-FG02-06ER86264
$749,700

The mid-infrared spectral region is ideal for measuring numerous airborne gases with high sensitivity because many gaseous chemicals have their strongest absorption features in this region, and atmospheric transmission windows are present. To measure different chemicals at significantly different wavelengths, a widely tunable laser is needed. Although a new type of mid-infrared laser, the quantum cascade laser, is currently available at selected wavelengths, it cannot be widely tuned. This project will develop an improved, mid-infrared, quantum-cascade-laser-based light source for spectroscopic remote sensing, along with associated optics and software. The laser source will have increased tuning range, tuning speed, and output power, realized by an external cavity laser configuration with a quantum cascade gain medium. The laser design will allow compensation for the effects of modest quality antireflection coatings, and will achieve wide and continuous tuning of the emission wavelength. Phase I developed and demonstrated the laser tuning technology at two different infrared wavelengths, exceeding the goals for tuning range (up to 155 wave numbers) and continuous output power (50 milliwatts). Remote sensing optics and instrumentation approaches were tested with a narrowly tunable quantum cascade laser, and gas concentrations were measured over a range path length greater than 280 meters. In Phase II, control techniques will continue to be developed to produce a more compact and rugged laser source with wider and faster tuning and higher power. Optics and software will be developed to interface to the new laser source, resulting in a prototype instrument for field testing.

A Cost-Effective Analytical Technology for Identification and Measurement of Greenhouse Gases (DOE 2007 SBIR Phase 1)
Dr. Gotze H. Popov, PI, 973-731-6281; popov@lenterra.com
Lenterra Inc., West Orange, NJ 07052; www.lenterra.com
DOE Grant No. DE-FG02-07ER84894
$99,742

This project will develop a portable gas analyzer that is capable of identifying and measuring the concentrations of CO2, CO, and other trace greenhouse gas constituents. The analyzer will combine a micro-gas chromatograph (GC) with a plasma detector based on Penning Ionization Electron Spectroscopy (PIES), and will provide sample identification that is independent of the GC retention time. In Phase I, (1) PIES spectra for a list of environmentally significant gases will be measured in the range of concentrations required for the environmental analysis; (2) sensitivity limits for CO, CO2, and N2O will be improved to ppb (parts per billion) range by making use of a preconcentrator; (3) PIES spectra for methane and CCl4 will be obtained, and the sensitivity for measuring chlorinated fluorocarbons (CFCs) will be tested; and (4) environmental trace constituents in air samples, collected in residential and industrial areas, will be measured. Phase II will result in the development of a cost-effective, portable autonomous platform for environmental gas analysis. The analyzer should be an attractive analytical device for a large variety of commercial applications, such as hazardous species detection, industrial process analysis, and breath control. The device also promises to be of interest to homeland security, oil and refining, and the chemical and petrochemical industries. The ruggedness and low energy and material consumption of the analyzer would permit efficient in situ environmental monitoring of air in workplaces, airports, hospitals, or schools.

Development of Aircraft Borne 13CH4 Analyzer Using a Continuous Wave Quantum Cascade Infrared Laser Spectrometer (DOE 2007 SBIR Phase 1)
Dr. Mark S Zahniser, PI, 978-663-9500; mz@aerodyne.com
Aerodyne Research, Inc., Billerica, MA 01821-3976; www.aerodyne.com
DOE Grant No. DE-FG02-07ER84889
$100,000

Methane is the second most important atmospheric greenhouse gas after CO2, yet its global sources and sinks are still inadequately characterized. Recent observations that industrial plants may account for a substantial fraction of atmospheric methane have lead to an increased emphasis on studies of ecosystem CH4 fluxes, with particular interest in using isotopic composition to identify specific production pathways. Field-deployable instruments for direct measurements of 13CH4, having sufficient precision without sample pre-concentration, do not yet exist. Recent advances in quantum cascade laser technology have made available continuous wave operation near room temperature without cryogenic cooling. With such devices, it is now feasible to develop a compact portable instrument with sufficient sensitivity for direct measurements of 13CH4. The portability would allow deployment from light aircraft to assess sources of methane in remote areas. Phase I will design and test a prototype optical system to demonstrate the ability to directly detect the ratio of 13CH4 to 12CH4, with a precision of 0.5 parts per thousand (0.5 ‰) in an averaging time of 30 seconds. Key design issues -- including laser line width, mode purity, required path length, temperature and pressure control -- will be quantitatively assessed. A preliminary design for an aircraft-borne instrument will be developed, and measurement opportunities for aircraft deployment will be identified. The instrument should be an attractive addition to existing atmospheric trace gas detectors, since it will be able to operate without cryogenic cooling of either the laser or the detector. Other applications would include air pollution monitoring, human breath analysis, and industrial process monitoring.

Early Remote Risk Assessment Survey Technology (DOE 2007 SBIR Phase 2)
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Physical Optics Corporation, Torrance, CA 90501-1821; www.poc.com
DOE Grant No. DE-FG02-06ER84613
$749,993

DOE is seeking development of risk assessment methodologies and simulation models to quantify and mitigate the accidental release of carbon dioxide and other noncarbon dioxide greenhouse gases from geologic formations. Current monitoring technologies cannot reveal concealed fractures in overburdened formations, which are the most probable path for carbon dioxide leaks. This project will develop an Early Remote Risk Assessment Survey Technology, which will identify potential zones of carbon dioxide leakage before geologic sequestration is initiated. The technology, based on differential absorption lidar, will measure multiple "geogases" (including methane, carbon dioxide, helium, argon, and hydrogen) to detect anomalies that can reveal potentially hazardous concealed zones of high permeability. In Phase I, a prototype differential absorption lidar was designed, assembled, and tested in laboratory conditions. Experiments demonstrated feasibility in detecting methane, argon, and carbon dioxide, individually and in mixtures. In Phase II, efforts will be concentrated on increasing the optical power of the laser light source; optimizing the receiving optics; designing a push-broom scanning mechanism; and developing geolocation, georegistration, and mapping software tools. When fully developed, the system should be able to identify from an aircraft surface geogas anomalies that indicate deep penetrating concealed faults and fractures, the major risk sources for accidental carbon dioxide release. The technology would allow DOE, at an early stage, to minimize risk in selecting sites for geologic carbon dioxide sequestration. Potential customers include government agencies and private companies engaged in environmental monitoring, pipe leak inspection, earthquake prediction, and nonproliferation control.

Field-Deployable Gas Analyzer for MMV Applications (DOE 2007 SBIR Phase 2)
Dr. Anthony O'Keefe, PI; 650-965-7772; a.okeefe@lgrinc.com
Los Gatos Research, Mountain View, CA 94041; www.lgrinc.com
DOE Grant No. DE-FG02-06ER84606
$728,099

In response to recent evidence confirming that anthropogenic CO2 emissions are disturbing the natural carbon cycle and resulting in global warming, DOE has pioneered a Carbon Sequestration Program to capture and store CO2 and other greenhouse gas emissions in geological sites. Despite initial research that suggested leakage rates would be low, there have been no definitive long-term studies. A recent review of carbon sequestration has identified monitoring, mitigation, and verification (MMV) as critical components of future activities. MMV instrumentation must be highly sensitive (< 0.5 ppm CO2), capable of covering a broad area (> 15 square miles), and able to distinguish between leakage of stored CO2 and natural, biological CO2 fluctuations. This project will employ a patented Off-Axis Integrated Cavity Output Spectroscopy technology to develop a field-portable gas analyzer for carbon sequestration MMV applications. The instrument -- which will provide in-situ, highly accurate quantification of CO2 concentration (< 0.5 ppmv), isotope ratio (δ13C < 1.0 ‰), and CH4 concentration, without calibration -- will be capable of monitoring surface leaks above geological formations and distinguishing between biogenic and injected carbon sources. Phase I fabricated a carbon isotope ratiometer that accurately measured deltaC-13 to better than 1.0‰ and CO2 concentration to better than 0.5 ppmv after only 100 seconds of measurement time. Moreover, the instrument maintained this high specification over a wide CO2 range (from 300 to 6,000 ppmv). In Phase II, three complete gas analyzer systems -- capable of quantifying the carbon isotope ratio (13C/12C) of CO2, the concentration of CO2, and the concentration of CH4 at ambient and subsurface levels -- will be developed. After thorough testing, the instruments will be deployed and evaluated at a DOE Carbon Sequestration Field Site and at a biological natural carbon sequestration site.

Field Portable Gel Element Arrays for Microbial Community Profiling in Subsurface Sediments and Groundwater (DOE 2007 SBIR Phase 2)
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Akonni Biosystems, Inc., New Market, MD 21774; www.akonni.com
DOE Grant No. DE-FG02-06ER84412
$749,970

A simple-to-use, microarray-based, environmental diagnostic device is needed to enable technicians and engineers to monitor the structure and dynamics of microbial communities in groundwater and subsurface environments. This project addresses this need by integrating complex molecular-microbiology operations into a fluidic architecture that can be mass produced at low cost and operated by any unskilled technician with a simple push of the button. Phase I identified the basic biochemical and technical methods required for microfluidic nucleic acid extraction, purification, labeling, microarray hybridization, and data analysis. Phase II will develop a standard-operating protocol for a gel element array; improve the efficiency of on-cartridge nucleic acid recovery from environmental samples; integrate the sample preparation, amplification, and microarray sub-circuits into a unified system; establish a semi-automated decision logic for interpreting the array data; and evaluate the integrated model and standard operating procedure with environmental samples impacted by metals, radionuclides, or organics.

High Precision CO2 Field Sensor (DOE 2007 SBIR Phase 1)
Dr. Joel A. Silver, PI, 505-094-1322; jsilver@swsciences.com
Southwest Sciences, Inc., Santa Fe, NM 87505; www.swsciences.com
DOE Grant No. DE-FG02-07ER84906
$100,000

The U.S. Global Climate Change Initiative (GCCI) has the goal of significantly reducing greenhouse gas emissions over the next 10 years; however, the sources and sinks of carbon dioxide and other greenhouse gases are not well understood. High-precision instruments to quantify the concentrations and fluctuations of carbon dioxide are essential to improve this understanding, yet existing instruments can not meet the combined specifications for precision, unattended field operation, and cost. In this program, a new type of high precision optical sensor, which combines traditional optical spectroscopy with a new, simple calibration method, will be developed. The sensor will provide significant improvement in detection sensitivity and precision for determining dry mixing ratios of carbon dioxide. The approach will address issues beyond performance, including the ability to be deployed in widespread field operations over extended periods of time. Federal benefits include low-cost, field-deployable instruments for the rapid and precise measurements of important gases (H2O, CO2, CH4, etc.) that will improve our knowledge for predicting and modeling atmospheric dynamics and climate change. The methodology also should be applicable to Homeland Security identification of chemical agents. In addition, the technology should has application for gas leak sensing of pipelines, fire detectors for commercial and private aircraft, combustor feedback control sensors, and process control sensors for the energy and chemical production industries.

Imaging the Stratigraphy Around a CPT Penetration Using a Combined ERT and CPT Method (DOE 2007 STTR Phase 2)

Dr. Wesley L. Bratton, PI, 509-737-1377; bratton@vistaengr.com
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Partnered with Lawrence Livermore National Laboratory, Livermore, CA
DOE Grant No. DE-FG02-06ER86292
$664,327

Improved technologies are needed to measure key factors that affect mass-transport rates in the shallow subsurface at large scales. Mass-transport parameters are important at large scales because flow and transport occurs on such scales. Although many technologies can make discrete point measurements of key parameters, few are able to expand and assess those parameters on a larger scale or provide maps of those parameters in a cross-section. This project will develop, evaluate, and demonstrate a commercially viable method for mapping the stratigraphy of the subsurface around cone penetrometer (CPT) penetrations. The approach will combine the point measurement capabilities of the CPT with the mapping potential of Electrical Resistance Tomography (ERT) so that key mass-transport parameters can be assessed. Numerical modeling computations and laboratory tests conducted during Phase I demonstrated that sufficient resolution could be obtained. In Phase II, additional numerical modeling will be performed to optimize the probe electrode spacing and measurement strategy. The goal is to optimize the number of unique measurements such that sufficient data is provided for the image inversion process. A CPT probe with 3 to 5 electrodes will be designed to both transmit electrical current and measure the electrical potential. The probe will be used in field tests to map the stratigraphy at a well-characterized site.

In Situ Analytical System for Remote Determination of 90Sr Flux Through the Aquifer (DOE 2007 STTR Phase 2)

Dr. Scott R. Burge, PI, 480-968-5141; burgenv@globalcrossing.net
Burge Environmental, Inc., Tempe, AZ 85283-2872; www.burgenv.com; Partnered with Battelle Memorial Institute, Richland, WA
DOE Grant No. DE-FG02-06ER86266
$747,802

The long-term monitoring of ground-water contamination plumes to determine the fate of contaminants is expensive and labor intensive. Current baseline methods have resulted in monitoring programs that collect less data than required to fully understand the fate and transport mechanisms of the contaminants. In this project, an automated, field-deployable monitoring system using a preconcentrating column sensor will be used to monitor strontium-90 concentrations. The system will be capable of being deployed and operated in the field for several months and will measure strontium-90 concentrations below the regulatory limit of 8 pCi/L. The system will provide more frequent data with less reporting delay at a lower cost than the baseline methods. In Phase I, a prototype analytical system was developed and tested. The system successfully detected strontium-90 below the regulatory limit and appeared to have the necessary attributes for deployment in the field. In Phase II, four systems will be field-deployed to demonstrate the near-real-time estimation of flux through the aquifer.

In-Situ Monitoring of the Radioactive Contaminant Tc-99 in Groundwater Using a Reagentless Equilibrium-Based Sensor (DOE 2007 STTR Phase 1)

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DOE Grant No. DE-FG02-07ER86303
$99,676

Technetium-99 is a significant contaminant of concern at DOE sites. It is a pure beta-emitting radionuclide with an extremely long half-life (t1/2=2.13 X 105 yrs) and is highly mobile in the environment. Because it is capable of migrating through an aquifer virtually unencumbered, it is essential that the plumes be closely monitored. In this project, an automated field-deployable monitoring system containing an equilibration-based preconcentrating minicolumn sensor will be used to monitor TC-99 concentrations. The system will be capable of being deployed unattended in the field for several months and measuring TC-99 concentrations below the regulatory limit of 900 pCi/L. The system should have application at DOE sites with radiological contaminants (e.g., the Hanford site). The system would decrease monitoring costs and enhance the understanding of the fate of radiologicals in the environment.

In-Situ Quantification and Speciation Analysis of Radionuclides via Fiberoptic Surface Enhanced Raman Spectroscopy (SERS) (DOE 2007 STTR Phase 1)

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SCI-TEC, Inc., Knoxville, TN 37932; www.sci-tec-inc.com; Partnered with Oak Ridge National Laboratory, Oak Ridge, TN
DOE Grant No. DE-FG02-07ER86325
$100,000

Real-time, in situ measurement and monitoring tools for interrogating biogeochemical processes in the subsurface environment are critical to assessing remediation performance and site stewardship at many contaminated DOE sites. In particular, in situ quantification and speciation analysis of important radionuclides are essential to facilitate the rapid identification of potential hazards, shorter turn-around times for analytical results, and improved stewardship. Current techniques for monitoring and characterizing radionuclides rely primarily on liquid scintillation counting, ICP-MS, and the limited use of spectrofluorimetry. These techniques often require chemical handling (for example, the use of scintillation cocktails in liquid scintillation counting) or complexing media (such as phosphoric acids) in order to enhance signals and selectivity in fluorimetry. Additionally, these analyses usually require high-cost capital equipment and a lengthy analytical time. This project will develop a new tool for in situ quantification and speciation analysis of radionuclides and other groundwater constituents via fiberoptic surface enhanced Raman spectroscopy (SERS). The specific objectives are to (1) develop new methods to detect and characterize important radionuclides (such as uranium and technetium) and other groundwater constituents (such as nitrate and sulfate) by exploiting recent breakthroughs in SERS; (2) optimize methodologies to synthesize SERS substrates with improved selectivity and sensitivity; and (3) fabricate a prototype fiberoptic SERS probe that can be interfaced with a portable Raman spectrometer for in situ measurements. A novel SERS technique for monitoring and characterizing radionuclides and other groundwater constituents in the subsurface environment also could be used to detect other priority environmental pollutants, such as perchlorate and chlorinated organic compounds, which are found at many contaminated sites. The estimated market is on the order of multi-millions of dollars per year.

Isotope Analyzer for Real-Time Measurements in the Field (DOE 2007 SBIR Phase 1)
Dr. Douglas Baer, PI, 650-965-7772; d.baer@lgrinc.com
Los Gatos Research, Mountain View, CA 94041; www.lgrinc.com
DOE Grant No. DE-FG02-07ER84895
$100,000

This project will employ Off-Axis Integrated Cavity Output Spectroscopy (Off-Axis ICOS) technology to develop, deploy, and test a field-portable methane isotope analyzer for the measurement of carbon isotope ratios (δ13C) and methane (CH4) concentrations in ambient air. The instrument will be capable of providing in situ, accurate quantification of both CH4 concentration and carbon isotope ratio for the real-time monitoring of methane sources and sinks in the biosphere and atmosphere (e.g., in landfills, geological formations). The instrument will distinguish between biogenic and injected carbon sources, and will identify and subsequently capture fugitive methane emissions. Phase I will build, test, and deploy a prototype instrument capable of real-time measurements of methane isotopomers in ambient air. The prototype will employ a high-finesse optical cavity as a measurement cell. Present technology is expensive and slow, and cannot provide on-site measurements of methane isotopomers in ambient air. A robust methane isotope analyzer should find uses in landfills, oil and gas exploration, and environmental research.

Low-Cost Small Diameter NMR Technologies for In-Situ Subsurface Characterization and Monitoring (DOE 2007 SBIR Phase 1)
Dr. David Oliver Walsh, PI, 425-290-3626; davewalsh@vista-clara.com
Vista Clara Inc., Mukilteo, WA 98275;
DOE Grant No. DE-FG02-07ER84931
$100,000

This project will develop low-cost, small-diameter NMR instrumentation and software for in situ characterization and monitoring of groundwater and water-bearing formations in the near subsurface. The effort will leverage magnet/coil designs and NMR techniques pioneered for deep petroleum exploration, and implement them in miniaturized, low-cost form factors suitable for hydrogeological investigations in the top 200 meters of the subsurface. Phase I will address the problem of characterizing and monitoring subsurface hydrogeological formations and groundwater transport processes within 200m of the earth's surface, including both the saturated and unsaturated (vadose) zones. Low-cost, minimally invasive, small-diameter instrumentation will be developed with associated software for direct subsurface measurement of groundwater and its hydraulic properties. The instrumentation and software should lead to low-cost commercial NMR hydrogeology analysis systems, packaged for use in various diameter boreholes and cone penetrometer applications. The technology would bring the unique advantages of in situ NMR measurements to a broad variety of subsurface hydrological investigations at a fraction of the cost of existing borehole NMR instruments and services.

Methane and Carbon Dioxide Eddy-Covariance Flux Monitor (DOE 2007 SBIR Phase 1)
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DOE Grant No. DE-FG02-07ER84902
$99,653

Methane (CH4), water vapor (H2O), and carbon dioxide (CO2) are collectively responsible for the majority of the Earth's greenhouse effect. Robust instrumentation that can measure these gases with both high accuracy and high precision would reduce the uncertainty in the determination of terrestrial sources and sinks of these dominant greenhouse gases. Such knowledge is needed to improve predictive models that lead to a better understanding of the human contribution to global warming. This project will build a CO2/ CH4 flux monitor based on the optical absorption technique, cavity ring-down spectroscopy (CRDS). Compared to other gas measurement techniques, CRDS is extremely sensitive and precise, and is well suited to provide rapid (10 Hz) and precise measurements of atmospheric CO2 and CH4. In addition, the analyzer will require far less calibration and sample preparation than currently available technology, leading to better reliability and reduced operating cost. Government agencies around the world are already installing atmospheric monitoring stations; for example the Ameriflux network currently has 89 active stations in six countries. An improved CO2 and CH4 flux monitor deployed at these stations would provide high accuracy as well as high precision information at a data rate required for flux measurement.

Miniature Spherical Retroreflectors Fabricated by Fluidized Bed CVD (DOE 2007 SBIR Phase 1)
Dr. Catherine Rice, PI, 732-302-9274; cerice@structuredmaterials.com
Structured Materials Industries, Inc., Piscataway, NJ 08854; www.structuredmaterials.com
DOE Grant No. DE-FG02-07ER84765
$100,000

As part of the DOE Proliferation Detection Program, miniature spherical lenses are sought for remote chemical detection using LIDAR. These miniature lenses can serve as retroreflectors for the atmospheric detection of chemical threat agents. Currently, there is no reliable method for producing these spherical lenses, which require a graded index profile of at least 0.2 over their entire radius, at a size in the few mm. This project will develop miniature spherical lenses with controlled refractive index profile using fluidized bed chemical vapor deposition (FBCVD). Phase I will demonstrate proof-of-concept by fabricating millimeter-sized, silica-based glass spheres with a defined and controllable index profile, and characterize their optical properties and quality. Phase II will expand the technology to include other material compositions, including chalcogenide glasses, to extend the transmission wavelength, tune index profiles, refine optical quality, and scale up for economical Phase III production. The graded index retroreflector spheres would enhance the capability of remote chemical sensing. These retroreflector spheres also could find use in other applications, including the remote monitoring of automobile exhaust and chemical and power plant effluent.

A New High-Resolution Method for the Characterization of Heterogeneous Subsurface Environments: Providing Flow and Transport Parameters via the Integration of MultiScale HydroGeophysical Data (DOE 2007 SBIR Phase 1)
Dr. Gilles Bussod, PI, 802-296-2401; gbussod@ner.com
New England Research, Inc., White River Junction, VT 05001; www.ner.com
DOE Grant No. DE-FG02-07ER84898
$99,973

Historically, remediation efforts at DOE contaminated sites have relied on numerical models to integrate laboratory and field characterization data, predict the fate and transport behavior of contaminant plumes, design remediation protocols to mitigate contaminant migration, and analyze data from field remediation results. Of particular concern is the effect of subsurface heterogeneities and their hydrologic and geochemical properties on the flow and transport of contaminants. High performance computations are now making it technically feasible to model the complex flow and transport processes occurring over a wider range of scales; however, these models are limited by the lack of fine-scale site-characterization data for use as realistic inputs and constraints in these detailed models. To improve the hydrophysical characterization of the subsurface and populate high-performance simulations with critical physically derived parameters, this project will use a high-resolution multiphysics scanner technology to characterize coupled hydrogeologic and geophysical properties of complex subsurface lithologies and structures. With the scanner data as input, software tools and physical models will be developed to enable DOE to integrate multiscale hydrogeophysics data and reduce uncertainty in the prediction of contaminant transport on a site-by-site basis. A new, improved, and marketable site-characterization method should lead to more efficient monitoring and verification activities, resulting in large cost savings over the life of remediation programs. In addition, the technology should directly benefit DOE's investment in massively parallel flow and model development. The technology also should be of use to the oil and gas industry.

Novel Instrumentation for Real-Time Combustion Monitoring and Control (DOE 2007 SBIR Phase 1)
Douglas Baer, PI, 650-965-7772; d.baer@lgrinc.com
Los Gatos Research, Mountain View, CA 94041; www.lgrinc.com
DOE Grant No. DE-FG02-07ER84672
$100,000

Effective monitoring and control of power plants, industrial furnaces, boilers, incinerators and other combustion systems is limited by the sensitivity, specificity, speed, and reliability of available sensors and control systems. As a result, industrial combustion-based processes operate with sub-optimal efficiency and release excessive toxic emissions, pollutants, and greenhouse gases. This project will develop a novel, robust instrument capable of accurately measuring and controlling multiple, critical combustion-exhaust emissions in real time, with unprecedented sensitivity and speed. The instrument, which will be based on tunable lasers and cavity-enhanced-absorption spectroscopy, will increase combustion efficiency and significantly reduce hazardous and toxic gas emissions. In Phase I, the instrument will be designed and built, and then combined with a closed-loop control strategy to optimize combustion efficiency and decrease pollutants and greenhouse gases and unwanted exhaust emissions. The instrument will be used in the exhaust of a laboratory combustor (Phase I) and in an industrial plant (Phase II), to validate performance and demonstrate an ability to make continuous measurements and exert control over extended periods. The instrument should be applicable to the monitoring and control of combustion emissions (e.g., from power plants, furnaces, boilers, incinerators); monitoring and control of industrial processes; monitoring of atmospheric pollutants and greenhouse gases; and engine diagnostics and automobile monitoring.

Open-Path Optical Ammonia Monitor DOE 2007 SBIR Phase 1)
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Southwest Sciences, Inc., Santa Fe, NM 87505; www.swsciences.com
DOE Grant No. DE-FG02-07ER84907
$100,000

The effects of aerosol particles on climate are the most uncertain aspects for quantifying the impact of human activities on future climate changes. Although ammonia plays a critical role in the formation and identity of atmospheric aerosol particles, ammonia is incredibly difficult to measure due to its low concentration in the atmosphere. Consequently, widespread and fast measurements of gas phase ammonia aerosols are greatly lacking. In addition, measurement artifacts are created by the challenges of sampling such an elusive gas. This project will develop a tunable, external-cavity, quantum-cascade light source for measuring ammonia in an open-path setup; no inlets or sampling lines will be needed. Patented, singular-value decomposition algorithms will be used to remove the effects of other atmospheric trace species on the spectral ammonia peak.

Real-Time Infrared Greenhouse Gas Sensor (DOE 2007 SBIR Phase 2)
Dr. Hans-Jurg Jost, PI; 650-610-0956; hjjost@novawavetech.com
NovaWave Technologies, Inc., Redwood City, CA 94065□5150; www.novawavetech.com
DOE Grant No. DE-FG02-06ER84424
$749,927

Improved greenhouse gas monitors are required to improve our understanding of atmospheric dynamics and climate change. In particular, highly accurate and robust sensors capable of monitoring fluxes and concentrations of key greenhouse gases, such as methane, are needed. This project will develop a greenhouse gas sensor based on a novel mid-infrared laser source. The laser -- which will provide high reliability, excellent beam quality, compact size, low power consumption, and room-temperature single-frequency operation -- will be combined with a rugged, miniaturized gas sampling system to enable long-term measurements of trace gas fluxes and concentrations. During Phase I, the mid-infrared laser source was constructed and characterized. The source was used in conjunction with a compact gas sampling system to demonstrate the fast and accurate determination of methane concentrations in atmospherically relevant gas mixtures. Phase II will involve the construction of an improved laser and integrated sensor prototype system. The system will be rigorously tested under both laboratory and field conditions to demonstrate autonomous greenhouse gas monitoring for extended periods of time. Phase II also will demonstrate the efficacy of the core sensor technology platform for numerous other gas sensing applications. The new sensor should find commercial application in trace gas monitoring, greenhouse gas monitoring for emissions compliance, hydrocarbon leak detection, and in a variety of industrial process control settings.

Real-Time Multispecies Greenhouse Gas Sensor (DOE 2007 SBIR Phase 1)
Dr. James J. Scherer, PI, 650-610-0956; jjscherer@novawavetech.com
NovaWave Technologies, Inc., Redwood City, CA 94065-5150; www.novawavetech.com
DOE Grant No. DE-FG02-07ER84929
$99,999

Improved trace gas monitors are required to improve our understanding of atmospheric dynamics and climate change. In particular, highly accurate robust sensors that are capable of monitoring fluxes and concentrations of multiple trace greenhouse gases, such as methane and carbon dioxide, are needed. This project will develop a sensor that is based on a new concept for a high-performance, mid-infrared laser source. The laser will possess many desirable qualities, including high reliability, excellent beam quality, compact size, low power consumption, and room-temperature single-frequency operation at multiple wavelengths. The laser will be combined with a rugged, miniaturized gas sampling system to enable long-term measurements of trace gas fluxes and concentrations in field settings. During Phase I, the new mid-infrared laser source will be constructed and fully characterized. The source will be used in conjunction with a compact gas sampling system to demonstrate the fast and accurate determination of atmospherically relevant gas mixtures. Designs for a fully automated multispecies Phase II sensor will be produced. Commercial applications for the sensor should be numerous, including trace gas monitoring at AmeriFlux and FLUXNET sites, greenhouse gas monitoring for emissions compliance, hydrocarbon leak detection, and industrial process control.

Tools for Full Spectrum Analysis of Hyperspectral Data (DOE 2007 SBIR Phase 2)
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Technical Research Associates, Inc., Honolulu, HI 96822
DOE Grant No. DE-FG02-06ER84642
$748,463

Hyperspectral sensor systems are currently under consideration for applications related to monitoring the nuclear fuel cycle and other signatures of interest to the nonproliferation community. These applications include the detection of camouflaged and concealed targets, gas plume detection and identification, and terrain classification. Many of the current data exploitation tools are not user-friendly and do not fully exploit all the spectral data available. For example, hyperspectral data from different frequency bands are analyzed separately. This project will develop technology to allow the analysis of the full spectrum, thereby increasing the probability of proper identification and reducing false alarms. During Phase I, the requirements were analyzed and several segmentation techniques -- Independent Component Analysis (ICA) and Non-Negative Matrix Factorization (NNMF) -- were implemented. In addition, the extension of the current Microcorder-rule-based spectral identification algorithm to the long wave infrared (LWIR) was investigated using data collected simultaneously by visible-near-infrared/short-wave-infrared (VNIR/SWIR) and LWIR hyperspectral sensors. In Phase II, software tools for the full spectrum analysis of hyperspectral data will be developed. Besides ICA and NNMF, other full-spectrum, compatible analysis techniques will be implemented. Specifically, the current Microcorder algorithm will be extended to the LWIR, so that rules for spectral matching can be applied over the full spectrum from VNIR to LWIR. These tools will be integrated into a user-friendly analysis package with other existing software and delivered with the software components level for integration into DOE hyperspectral analysis packages.

Tunable Infrared Quantum Cascade Lasers for Active Electro-Optical Remote Sensing (DOE 2007 SBIR Phase 2)
Dr. Timothy Day, PI, 858-391-0377; tday@daylightsolutions.net
Daylight Solutions, Inc., Poway, CA 92064-8809; http://www.daylightsolutions.net
DOE Grant No. DE-FG02-06ER84631
$750,000

Remote sensing of airborne chemicals from industrial or illicit emissions is greatly facilitated by looking for characteristic absorption patterns of mid-infrared (IR) light with wavelengths from 3 to 14 um. DOE can use this type of remote sensing to monitor and detect effluents from nuclear fuel cycle processes, for example. At present, there is no robust and reliable way to generate an intense beam of mid-IR light that can be tuned in wavelength to look for these absorptions. In this project, a high power, tunable, mid-IR laser will be designed and built for use in remote sensing applications. State-of-the-art quantum cascade laser (QCL) technology will be incorporated in a miniaturized, tunable laser cavity to provide a field-ready, mid-IR light source to enable detection of airborne chemicals. Phase I developed materials suitable for incorporation in a miniaturized tunable laser cavity. Tunable near-IR diode laser technologies were extended to the mid-IR to enable design and construction of a miniaturized, tunable, mid-IR laser platform. Several prototypes were built that demonstrated pulsed tunable mid-IR lasers. In Phase II, the platform technology will be extended to achieve the continuous wave (CW) lasers that are necessary for remote sensing. The laser cavity design and quantum cascade (QC) device coatings will be optimized to allow continuous tuning of the CW lasers. CW QC devices, throughout the entire mid-IR, will be designed and developed.

U.S. Geological Survey, Water Resources Research Institute

Advancing the Characterization of Fractured Bedrock Aquifers Using Electrical Geophysical Methods: Application to Water Resources Evaluation in the New Jersey Highlands (USGS 2006 WRRI Research Grant)
DeBonne N. Wishart and Lee D. Slater, Rutgers University (co-PIs)
USGS/New Jersey Water Resources Research Institute (WRRI)
Project 2006NJ98B
1/03/06 to 2/28/07

This project initiates hydrogeophysical research in the New Jersey Highlands directed towards improving water resources management and reducing aquifer vulnerability in the region. Rather than relying solely on traditional collinear (symmetric) azimuthal resistivity surveys alone to characterize fracture anisotropy as was done in previous investigations, asymmetric azimuthal arrays of ASP and ARS measurements are coupled with hydrologic measurements to characterize fractures at the laboratory and extended to the field scale. Two-thirds of the research completed has allowed the investigators to (1) improve the effectiveness of electrical geophysical methods in the hydrogeologic characterization of fractured bedrock aquifers, (2) devise a method to delineate hydraulically active fractures, (3) extend bench-scale laboratory research to the field

sites, and (4) apply methods to improve understanding of fracture geometry in the north New Jersey Highlands (NJH). The complex fracture geometry in the bedrock of the NJH region encourages the application of integrated geophysical methods that are sensitive to hydraulic anisotropy, the direction of groundwater flow, and heterogeneity. The program of research investigates how integrated geoelectric measurements can be used to distinguish hydraulically conductive fractures and to infer direction (and possibly rates) of groundwater flow based on the electrokinetic phenomena associated with 'streaming' or self potential (SP). The third and final experiment for the completion of the project will involve the application of electric geophysical methods used in earlier experiments to characterize fractures created in a clay formation by the Pneumatic Fracturing Technology(r), an engineering application that serves to enhance fluid flow and reduce transport limitations inherent at many remediation sites. Patented in 1992, the Pneumatic Fracturing Technology(r) has emerged as one of the most cost-effective methods for enhanced remediation of contaminated groundwater and soils over the last decade. The objective of this study is to investigate the relationship between fracture propagation pressure and the simultaneous injection of a liquid by capitalizing on the in situ electrokinetics to increase the capability to detect the advance of injectate/contaminant through hydraulically conductive fractures. [See the project report in the New Jersey Water Resources Research Institute Annual Technical Report, FY 2006, pages 51 - 68.]
http://njwrri.rutgers.edu/pdfs/FY2006_NJ_Annual_Report.pdf

Compound Specific Isotope Analysis of Natural Attenuation Activity in Chlorinated-Solvent Contaminated Aquifers (USGS 2007 WRRI Research Grant)
Mark Brusseau, PI
USGS/Arizona Water Resources Research Institute (WRRI)
Project 2007AZ198B
3/01/2007 to 2/29/2008
Grant Amount/Matching Funds: $10,000/$20,827

The sustainability of potable water supplies is a critical issue in Arizona, given the recent and ongoing population increase, economic expansion, and arid climate. A major component of water-resources sustainability is the contamination of vital groundwater supplies by hazardous chemicals. In Arizona, chlorinated solvents, including tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC), are the primary contaminants at 43 of 48 state and federal Superfund sites. In aggregate, these sites comprise billions of liters of contaminated groundwater. Accordingly, these chlorinated-solvent contaminated sites pose a significant and long-term risk to the sustainability of potable groundwater in Arizona. Recently, monitored natural attenuation (MNA) has garnered increasing interest as a low-cost, effective solution for remediation of contaminated groundwater. The successful application of MNA has the potential to save millions of dollars in remediation costs, as well as to protect the quality of critical groundwater resources. The goal of this project is to provide a simple and broadly applicable method to assess the feasibility of using MNA at chlorinated-solvent contaminated sites in Arizona. The availability of such a method would greatly enhance the ability to evaluate sites quickly and effectively, thereby providing valuable information for site owners and regulators. One potential low-cost, rapid method for directly identifying the presence of biological natural attenuation processes is Compound Specific Isotope (CSI) analysis. This method takes advantage of the natural fractionation of carbon isotopes during biological transformation. The specific objective of this project is the development of CSI analysis methods that will permit rapid and accurate screening of the suitability of Arizona sites for MNA.

Development of a Cost Effective Methodology for In-Field Screen Testing of Water Quality (USGS 2007 WRRI Research Grant)
Zhongyang Cheng (Auburn University); Yucheng Feng; Tung-shi Huang (co-PIs)
USGS/Alabama Water Resources Research Institute (WRRI)
Project 2007AL63B
3/01/2007 to 2/29/2008
Grant Amount/Matching Funds: $24,997/$51,174

Due to the importance of water quality and the complexity of the problem, U.S. EPA has implemented many technologies for monitoring water quality. For example, EPA recommends E. coli as the best indicator of health quality standards, and therefore should be monitored accordingly. All the technologies recommended by the EPA are laboratory-based and require trained personnel. The water samples must be delivered to a lab from various sample sites within 6 hours on ice, and the analysis includes a 24-hour incubation period. To test water quality in a real-time manner, a biosensor would be a strong candidate. Many types of biosensors have been developed or are currently under development, but to date there is no biosensor/methodology suitable for in-field screen testing of water quality. This project proposes to develop a methodology for monitoring water quality in a real-time manner that will be ideal for in-field screen testing. The device/system will be easy to operate so that anyone who can use a cell phone can run it. More importantly, the methodology will be cost effective. The portable interrogating system, which has a long lifetime, would cost only a couple of hundred dollars. The sensors (magnetostrictive particles or MSPs immobilized with a receptor, such as an antibody), are disposable and environmentally friendly and would cost only a few cents per test. This project proposes to develop a prototype device for detecting E. coli and Salmonella bacteria as well as other pathogenic bacteria in surface water using the MSP technology.

Development of a New Generation of Sensitive, Fluorescence-Based Nitrate Sensors for Use in Soil and Water (USGS 2007 WRRI Research Grant)
Shawn Christopher Burdette (University of Connecticut); Zoe G. Cardon, co-PIs
USGS/Connecticut Water Resources Research Institute (WRRI)
Project 2007CT130B
9/01/2007 to 8/31/2009
Grant Amount/Matching Funds: $17,892/$36,489

Our aim is to start development of a new generation of nitrate sensor for use in soil solution or in fresh water. The development of this sensor would be particularly helpful in monitoring efforts where persistent low levels of nitrate (rather than extremely high concentrations, like sewage plant emissions) need to be measured. Interest in monitoring nitrate in soil solution and freshwaters is immediate, and although there are nitrate sensors on the market currently, their sensitivity is geared toward hot spots such as plumes of contaminated water flowing from sewage treatment plants or from agricultural waste. A sensitive, relatively inexpensive, and miniaturized nitrate sensor is sorely needed by the monitoring, ecological, and environmental engineering communities. Working together, Burdette and Cardon have the expertise to design, prepare and develop more sensitive nitrate sensors for use in soils and freshwaters that emphasize sensitivity in the range of 0-3 mg per liter found in many uncontaminated local waters in New England and around the United States. Fluorescent sensors are extremely useful chemical tools for measuring concentrations of metal ions, anions and small molecules in a variety of environments because of their sensitivity, ease of use, small size and low cost. Miniature, inexpensive fluorescent sensors can be deployed in arrays over wide areas and monitored easily for extended periods of time. Although sensors exist for a variety of analytes, there are very few viable fluorescent sensors for nitrate available, and none has been developed to the point of commercialization. Because of its unique chemical properties, binding and detecting nitrate represents a significant challenge. To address these issues, several strategies for engineering dendrimer-based sensors have been proposed. Dendrimers are particularly amenable to environmental sensing applications because of their robust structures (making them reusable) and ease of synthesis. All three strategies rely on binding and accumulating the negatively charge nitrate to generate a fluorescence response. In the first strategy, negative charge induces an isomerization of a fluorophore from a non-emissive to fluorescent form; the second involves nitrate displacing quenching ions from dendrimer cores; and in the third, coupling dendrimer swelling to changes in fluorescence resonance energy transfer (FRET) between two fluorescent molecules. Each sensor system takes advantage of nitrate receptors designed to bind nitrate selectively in the presence of other anions present in nature. While the initial stage of the research project will address basic sensor design and detection strategy, the ultimate goal is integration of these molecular sensors into user-friendly devices.

Development of Microscale Membrane Extraction for Trace Monitoring of Pesticides and other Emerging Pollutants in Water (USGS 2007 WRRI Research Grant)
Somenath Mitra; Kamilah Hylton (New Jersey Institute of Technology), co-PIs
USGS/New Jersey Water Resources Research Institute (WRRI)
Project 2007NJ132B
3/01/2007 to 2/29/2008
Grant Amount/Matching Funds: $5,033/$11,743

This study will focus on the development of a low-cost, simple technique that can detect low concentrations of PFOS, PFOA, sulfamethoxazole, trimethoprim, clarithromycin, azithromycin, erythromycin and ciprofloxacin in water in a rapid, cost-effective manner. The use of a highly selective membrane liquid and trapping solution is being proposed to achieve high enrichment of these compounds, leading to shorter analysis times and lower detection limits. Specific objectives of the proposed work are as follows: (1) Develop micro-scale membrane extraction as a simple cost-effective tool for high enrichment of emerging pollutants to enable ppb-level detection; (2) Develop an on-line technique for real-time water monitoring.

Enhanced Reductive Dechlorination of Chlorinated Aliphatic Hydrocarbons: Molecular and Biochemical Analyses (USGS 2007 WRRI Research Grant)
Bill Hickey, PI
USGS/Wisconsin Water Resources Research Institute (WRRI)
Project 2007WI164B
3/01/2007 to 2/29/2008
Grant Amount/Matching Funds: $42,918/$35,277

Chlorinated aliphatic hydrocarbons are pervasive groundwater contaminants for which enhanced reductive dechlorination (ERD) via electron donor augmentation is a major bioremedial technology. A primary goal of ERD is to stimulate late-stage reactions (primarily dechlorination of cis-dichloroethene (c-DCE) and vinyl chloride (VC) to ethene), which field data indicate proceed most effectively under methanogenic conditions. The microbial communities effecting late stage reactions are unknown, however, and the biodegradative pathways operative under methanogenic conditions are not fully understood. This project will further our understanding of the microbes and microbial communities mediating biodegradative transformations that are key to effective ERD as it is applied in the field. By using a combination of phylogenetic and functional markers for microbial community analysis, we will gain information on the diversity and types of potentially important fermentative organisms as well as the dechlorinators. Integrating data from controlled microcosm tests and field tests may allow us to triangulate on particular organisms that carry out key functions in situ. We will learn how dynamics in microbial community composition, genetic markers and biochemical markers (e.g., fermentation products) correlate with changes in dechlorination activity, and thereby identify markers potentially useful as diagnostic tools for process assessment in the field. Objectives: (1) Delineate the microbial community dynamics induced by carbon source augmentation in microcosm and field samples. (2) Elucidate the composition of methanogenic communities that effect complete dechlorination of CAH in microcosm and field samples (3) Delineate the dynamics of CAH degradation and fermentative reactions in microcosm samples and during the progress of a field-scale application of ERD. (4) Apply numerical methods to microcosm and field data to develop correlations between microbial community composition, biochemical markers and dechlorination activity. The field site will be a CAH-contaminated aquifer located in southeastern Wisconsin, which is scheduled to begin ERD treatment (carbon source amendment) in April of 2006. Sediment and water samples will be collected prior to initiation of ERD treatment, and used to establish baseline microbiological and biogeochemical parameters. Microcosms will be established with aquifer sediments, and amended for ERD treatment as applied to the field site. Periodically, field and microcosm samples will be analyzed for CAH, CAH degradation products, biochemical markers and microbial community composition. The latter will include automated ribosomal intergenic space analysis and polymerase chain reaction analysis of reductive dehalogenase genetic markers.

The Formation of Preferential Pathways in Permeable Reactive Barriers in Cold Climates Due to Ice Formation (USGS 2007 WRRI Research Grant)
David L. Barnes; Yuri Shur (co-PIs)
USGS/Alaska Water Resources Research Institute (WRRI)
Project 2007AK63B
Grant Amount/Matching Funds: $27,837/$10,650
Mar 1, 2007 - Feb 28, 2008

Permeable reactive barriers (PRBs) are used in the remediation of contaminated groundwater. The efficiency of the barriers in cold regions is affected by ice formation in the pore space and the subsequent formation of preferential flow paths. This study will (1) use state-of-the-art x-ray computed tomography to visualize and quantify preferential pathways within barrier media, (2) identify the conditions necessary for preferential flow to occur, (3) propose measures to mitigate preferential flow and its effects, and (4) develop design recommendations for cold-region PRBs.

Identification and Control of Membrane Bioreactor Biofouling Organisms Using Genetic Fingerprinting--Year 2 (USGS 2007 WRRI Research Grant)
Roger Babcock (University of Hawaii), PI
USGS/Hawaii Water Resources Research Institute (WRRI)
Project 2006HI159B
3/01/2006 to 2/29/2008
Grant Amount/Matching Funds: $27,042/$29,020

Membrane bioreactors (MBRs) are a relatively new wastewater treatment technology that combines several typical unit operations (primary sedimentation, activated sludge aeration and sedimentation, and tertiary media filtration) into a single treatment step. This allows production of water suitable for recycling (unrestricted use) in a simple and compact system consisting of only a fine screen, an MBR, and a reduced-strength disinfection system. Like other membrane systems but to a greater degree, MBRs are susceptible to biofouling. Biofouling is not well understood but does increase operating pressure, reduce maximum flux (water passed through the membrane), increase recovery cleaning requirements, and possibly reduce total membrane life. All of these effects of biofouling have adverse effects on either initial capital cost or ongoing operation and maintenance costs for MBRs. The overall goal of this research will be to obtain a better understanding of biofouling in MBRs and methods to control said fouling in order to improve the economics of water recycling. The study will include long-term operation of two bench-scale MBRs under different conditions and evaluating membrane biofouling as a function of microbial population analysis using genetic fingerprinting. Biofouling will simultaneously be related to various water quality and operational parameters such and transmembrane pressure (TMP), biofilm thickness, soluble microbial products (SMP), extracellular polymeric substances (EPS), viscosity, particle size distribution (PSD), soluble COD, and sludge filterability. Pilot-scale MBRs operated for a separate project will also be sampled as well as full-scale conventional activated sludge systems for comparisons. The various findings will be evaluated and relationships determined between microbial speciation and resultant water quality parameters and membrane fouling states. This information will be integrated into a chart/decision-tree format useful for predicting fouling conditions as a function of operating parameters and based on dominant bacteria species. The 20-year life-cycle MBR system costs associated with different fouling states will be estimated and integrated into a separate chart/graph which can then be used to determine the most economical operating conditions for water recycling.

An Investigation into Subsurface Sampling and Characterization Efficiency Using a High Resolution GIS Based Earth System (USGS 2007 WRRI Research Grant)
Bernhardt Saini-Eidukat (North Dakota State University), PI
USGS/North Dakota Water Resources Research Institute (WRRI)
Project 2007ND148B
3/01/2007 to 2/29/2008
Grant Amount/Matching Funds: $2,000/$4,000

Several contaminant spills have taken place in North Dakota in the recent past. Though significant amount of data has been collected, one of the needs identified to manage remediation better is 3-D characterization of the sites. Most investigators of contaminated sites currently use traditional sampling methods, such as hollow-stem and auger coring, hand-held photo-ionization detectors (PID), and laboratory analysis, to determine the source and extent of subsurface contaminant source terms. These methods are very time consuming. Laser-induced fluorescence (LIF) screening methods can greatly reduce the time constraints of site characterization. Investigators can now create 3-D models in situ and in real time. The objectives of the research are to model site using "real world" data and modern geostatistical theory in 3-D and to provide an optimized method to characterize a contaminated site by simulation. Computer simulations can be done for a wide variety of contaminant types and distribution conditions to optimize the type of approach needed for classes of sites. An eventual goal will be to implement statistical algorithmic methods that create an optimum sampling grid for logging locations, given preliminary input parameters such as site dimensions, previous studies, and soil gas concentrations. This research has the potential of significant gains in the efficiency and cost-effectiveness of delineating many NAPL contaminant sites and plumes that remain uncharacterized.

Nanoscale Modification and Functionalization of Carbon Electrodes for the Detection of Harmful Organic Chemicals in Water such as Phenol and Domoic Acid (USGS 2007 WRRI Research Grant)
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USGS/Ohio Water Resources Research Institute (WRRI)
Project 2007OH49B
9/01/2007 to 8/31/2008
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The presence of harmful organic chemicals produced by human activities and naturally occurring biological toxins released from microorganisms (including phenol) in our drinking water and domoic acid in ecosystems is a serious threat to human and environmental health due to their carcinogenic and lethal properties. As a result, in parallel with the effective treatment of the toxic water contaminants (toxins), there is an urgent need to develop more innovative and effective in situ measurement methods to detect such toxins of interest in water and assess their environmental fate and distribution in water bodies and ecosystems. In this proposal, we investigate novel ideas to synthesize and evaluate nanostructured electrodes to detect phenol and domoic acid. Typical carbon electrodes are modified with nanostructured TiO2 with a tailor-designed porous structure for facilitating adsorption of the target compound of interest and further functionalized with chitosan-tyrosinase composite film, enhancing the selectivity and sensitivity of the electrode towards phenol and domoic acid. The nanostructured TiO2 chitosan/tyrosinase modified carbon electrode is able to easily monitor the compounds in situ using electrochemical instrumentation. The electrode developed here should meet the profitable features of electrode, including quantitative and qualitative detection, sensitivity, mechanical stability, physical rigidity, and enhanced catalytic properties. The study is a collaborative, multidisciplinary effort between Dr. Dionysios Dionysiou with expertise in environmental chemistry and nanoscale science (Civil and Environmental Engineering, University of Cincinnati) and Dr. Suzanne Lunsford with expertise in electrochemistry and sensing (Chemistry, Wright State University). We anticipate this new electrode could be used in several chemical sensor applications for environmental and biological molecules of interest in water.

Rapid and Sensitive Determination of Bacteria in Water Using Nanoparticles (USGS 2007 WRRI Research Grant)
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USGS/North Dakota Water Resources Research Institute (WRRI)
Project 2007ND151B
3/01/2007 to 2/29/2008
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Potable water is a major source of some bacteria colonization, for example L. pneumophila and E. coli. etc. The L. pneumophila in potable water can replicate rapidly and increase in virulence. The British Communicable Disease Surveillance Center reported that 19 of 20 hospital outbreaks of Legionnaires' Disease in the United Kingdom from 1980 to 1992 were attributed to Legionella-contaminated potable water. Given the low infectious dose of pathogenic bacteria, the presence of even a single bacterium in potable water may pose a serious health risk; hence, sensitive and rapid detection of bacteria in water is critical. The current definitive method for the detection of bacteria is by culture of the organism, which requires about 24 hours for bacterial growth. The method is too slow. The PCR-based method can detect bacteria within six hours, but the method requires pre-enrichment of the target bacteria. The objective of this proposal is to develop a rapid and ultra-sensitive method for the specific identification and quantitative determination of pathogenic bacteria in water. The major feature of the proposed method is the employment of fluorescent nanoparticles as target bacteria identifiers that could emit strong fluorescent signals. The method will consist of three major steps. First, the nanoparticles need to react with a specific antibody to form a conjugate of nanoparticle-antibody (NP-Ab). Second, based on the antibody-antigen reaction, the NP-Ab conjugates have to identify target bacteria cells from a sample by attaching the NP-Ab to the bacteria surface antigen. Third, target bacteria need to be qualitatively and quantitatively determined by measuring the fluorescence intensity and wavelength.

A Real-Time Permittivity Sensor for Simultaneous Measurement of Multiple Water-Quality Parameters (USGS 2007 WRRI Research Grant)
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USGS/Kansas Water Resources Research Institute (WRRI)
Project 2005KS40B
3/01/2005 to 2/28/2008
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This continues an existing KWRI project. The main objective of the proposed work is to develop a novel, frequency response-based permittivity sensor to detect and measure the concentrations of several types of pollutants in surface water and groundwater that are crucial to water quality. Since the beginning of the project in March 2003, we have designed and fabricated the sensor and associated signal conditioning, processing, and control circuit. For the sensor, we used a cascaded-electrode structure to enlarge the capacitive effect. The hardware involved a signal generator board, a gain and phase detector board, and a microcontroller to control the boards. Laboratory tests were conducted to observe the frequency response (gain and phase) of different types of waters, including lake, stream, tap, and distilled waters, and air. Significant differences were observed in both gain and phase responses. For waters, the differences were found mainly in frequencies below 35 MHz; however, between two different types of dielectric materials, such as water and air, the differences can be seen throughout the 200 Hz-120 MHz frequency range tested. This gives a clear indication that the sensor is capable of detecting differences in dielectric properties. Water samples with different combinations of soil sediment and salt (KCl) concentration levels were tested using a circulation system that provided uniform sediment concentrations. The sensor accurately measured KCl concentrations at each sediment concentration level. For sediment concentration measurement, the sensor only gave accurate measurement in water without added KCl and with KCl concentration of higher than 5.000 mg/L. For simultaneously measurement, the R-square values reached 0.86 and 0.87 for KCl and sediment, respectively. During the second year, a systematic lab experiment will be conducted to test the sensor with different types and amounts of sediments nutrients, and pesticides. First, these parameters will be measured separately to study effects of different pollutants on the conductive and capacitive behaviors. Combinations of the parameters will then be measured simultaneously using prediction models established based on the frequency-response data. Various pattern-recognition methods, including statistical multivariate analyses and neural networks, will be used to establish the prediction models. Field tests will then be conducted at existing USGS real-time continuous stream and lake monitoring installations with the cooperation of USGS water quality specialists. Based on experiences obtained from the laboratory and field tests, the sensor's structure will be further improved to enhance the portability and ease-of-use. The hardware will be modified to reduce the effect of parasitic impedance that may affect the high-frequency performance of the sensor. Different options for data storage and transmission will be studied. One of them will be real-time, wireless transmission to the Internet through a commercial wireless-phone system.

WRI 97: Chemical and Flow Characterization of Mining Impacted Streams Using Continuous Water Quality Monitoring and Watershed Modeling (USGS 2007 WRRI Research Grant)

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Project 2007WV98B
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Discrete water quality samples often do not represent adequately the true constituent load of a system. Although many parameters can be monitored continuously, these typically do not include the major parameters of concern in watersheds impacted by acid mine drainage (AMD). AMD-related parameters can be estimated through the combination of continuously monitored data and periodic water chemistry analysis. Continuous estimates of chemical concentration can provide a more accurate and detailed understanding of water chemistry dynamics and chemical loads in AMD impacted streams. Continuous data also can be used to evaluate the accuracy of water quality predictions made by models such as the Watershed Characterization and Modeling System (WCMS). The primary objective of this study is to develop regression equations that will relate continuously monitored data to parameters of interest in AMD-impacted watersheds. We will continuously monitor several water quality parameters in an AMD-impacted watershed and use regression analysis to identify surrogates for parameters such as iron and aluminum. A secondary objective of the study is to use continuous water quality data to evaluate the predictive ability of WCMS. We will produce error bounds for WCMS estimates, greatly enhancing the utility of WCMS for water chemistry estimations. The final objective of this project is to use continuous water quality data to examine spatial and temporal variability of water chemistry in the watershed. The information provided by this continuous data collection will assist in the construction of effective AMD treatment systems, and may provide a valuable tool for total maximum daily load (TMDL) development.