# Measurement & Monitoring:
# 24th Quarterly Literature Update

These references have been added to the literature database developed for the Measurement and Monitoring Technologies for the 21st Century ($21M^2$) website. The searchable archive of abstracts is located at www.clu-in.org/programs/21m2/litsearch.cfm

Advantages of Vinyl Chloride Reductase: Gene Testing in Bioremediation
Dennis, P.C. (SiREM/CANADA), X.M. Druar, A.S. Waller, and E.A. Edwards.
The Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, (Monterey, CA; May 2006): Book of Abstracts. Battelle Press, Columbus, OH. 2006

In the biodegradation process of chlorinated ethenes it is usually important that the process extend to ethene whether done naturally or through biostimulation or bioaugmentation. To date, only one vinyl chloride (VC) reductase has been purified and the gene sequence identified (*vcrA*). Not all *Dehalococcoides* species contain this sequence or one that is potentially a VC degrader. As part of the steps necessary to show that bioremediation is feasible at a site the microbial testing should include showing that not only will the degradation processes not stall at 1,2-dicloroethene, but also that it will not stall at VC. The authors argue that the standard 16s rRNA gene test will not resolve this issue and assays that look for functional VC-reductase genes should be included in the tests. This website provides additional discussion: http://www.siremlab.com/pdf/Why_Bacteria_Matter_Pollution_Engineering.pdf

Analysis of Dioxins in Contaminated Soils with the Calux and Caflux Bioassays, an Immunoassay, and Gas Chromatography/High-Resolution Mass Spectrometry
Nording, M., M.S. Denison, D. Baston, Y. Persson, E. Spinnel, and P. Haglund, Umea Univ., Umea, Sweden.
Environmental Toxicology and Chemistry, Vol 26 No 6, p 1122-1129, June 2007

The chemically activated luciferase expression assay, the chemically activated fluorescence expression assay, and the enzyme-linked immunosorbent assay (ELISA) are bioanalytical methods used for the detection and quantification of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs). The authors have evaluated the performance of each of these methods for analyzing PCDD/Fs in aliquots of extracts from aged contaminated soil samples and compared the results with those obtained by gas chromatography/high-resolution mass spectrometry (GC/HRMS). Results from the bioanalytical techniques were, in principle, not significantly different from each other or from the GC/HRMS data. Properly used, all of the techniques were found to be sufficiently sensitive, selective, and accurate to be used in connection with soil remediation activities when aiming at the remediation goal recommended by U.S. EPA (i.e., <1000 pg toxic equivalency/g); however, a site-specific correction factor should be applied when using ELISA to account for differences between the toxic equivalency factors and the ELISA cross-reactivities of the various PCDD/F congeners, which otherwise might significantly underestimate the PCDD/F content.

Application of a High-Density Oligonucleotide Microarray Approach to Study Bacterial Population Dynamics during Uranium Reduction and Reoxidation
Brodie E.L. (Lawrence Berkeley National Lab., Berkeley, CA); T.Z. DeSantis; D.C. Joyner; S.M. Baek; J.T. Larsen; G.L. Andersen; T.C. Hazen; P.M. Richardson; D.J. Herman; T.K. Tokunaga; J.M. Wan; M.K. Firestone.
Applied and Environmental Microbiology, Vol 72 No 9, p 6288-6298, 2006

Reduction of soluble uranium U(VI) to less-soluble uranium U(IV) is a promising approach to minimize migration from contaminated aquifers. Under constant reducing conditions, U(IV) is generally assumed to be stable and immobile; however, reoxidation of U(IV) under continuous reducing conditions has been documented. To determine if changes in microbial community composition were a factor in U(IV) reoxidation, scientists employed a high-density phylogenetic DNA microarray (16S microarray) containing 500,000 probes to monitor changes in bacterial populations during this remediation process. Comparison of the 16S microarray with clone libraries demonstrated successful detection and classification of most clone groups. Analysis of the most dynamic groups of 16S rRNA gene amplicons detected by the 16S microarray identified five clusters of bacterial subfamilies responding in a similar manner. This approach demonstrated that amplicons of known metal-reducing bacteria such as Geothrix fermentans (confirmed by quantitative PCR) and those within the Geobacteraceae were abundant during U(VI) reduction and did not decline during the U(IV) reoxidation phase. The observed reoxidation of uranium under reducing conditions occurred despite elevated microbial activity and the consistent presence of metal-reducing bacteria. High-density phylogenetic microarrays constitute a powerful tool, enabling the detection and monitoring of a substantial portion of the microbial population in a routine, accurate, and reproducible manner.

The Application of Single Particle Aerosol Mass Spectrometry for the Detection and Identification of High Explosives and Chemical Warfare Agents
Martin, Audrey Noreen, Master's thesis, Michigan State Univ.
UCRL-TH-226382, 112 pp, 2006

Single particle aerosol mass spectrometry (SPAMS) was evaluated as a real-time detection technique for single particles of high explosives. Dual-polarity time-of-flight mass spectra were obtained for samples of TNT, RDX, and PETN; peaks indicative of each compound were identified. Composite explosives, Comp B, Semtex 1A, and Semtex 1H were also analyzed, and peaks due to the explosive components of each sample were present in each spectrum. Mass spectral variability with laser fluence is discussed. The ability of the SPAMS system to identify explosive components in a single complex explosive particle (~1 pg) without the need for consumables is demonstrated. SPAMS was also applied to the detection of Chemical Warfare Agent (CWA) simulants in the liquid and vapor phases. Liquid simulants for sarin, cyclosarin, tabun, and VX were analyzed; peaks indicative of each simulant were identified. Vapor phase CWA simulants were adsorbed onto alumina, silica, Zeolite, activated carbon, and metal powders that were directly analyzed using SPAMS. The use of metal powders as adsorbent materials was especially useful in the analysis of triethyl phosphate , a VX simulant, which was undetectable using SPAMS in the liquid phase. The capability of SPAMS to detect high explosives and CWA simulants using one set of operational conditions is established.
http://www.llnl.gov/tid/lof/documents/pdf/340113.pdf

The BC Cribs & Trenches Geophysical Characterization Project: One Step Forward in Hanford's Cleanup Process
Benecke, Mark, Dale Rucker, and Mark Sweeney.
Waste Management 2006, 26 February - 2 March, Tucson, Arizona, 14 pp, 2006

A geophysical characterization project was conducted at the BC Cribs and Trenches Area at the Hanford Site. The area consists of 26 waste disposal trenches and cribs, which received ~30 million gallons of liquid waste from the uranium recovery process and the ferrocyanide processes associated with wastes generated by reprocessing nuclear fuel. Waste discharges to BC Cribs contributed perhaps the largest liquid fraction of contaminants to the ground in the 200 Areas. The site also includes possibly the largest inventory of Tc-99 ever disposed to the soil at Hanford, with an estimated quantity of 400 Ci. Other waste constituents included high volumes of nitrate and U-238. The geophysical characterization at the 50 acre site was conducted primarily with high resolution resistivity (HRR). The resistivity technique is a non-invasive method by which electrical resistivity data are collected along linear transects, and data are presented as continuous profiles of subsurface electrical properties. The transects ranged in size from about 400 to 700 meters and provided information down to depths of 60 meters. The site was characterized by a network of 51 HRR lines with a total of approximately 19.7 line kilometers of data collected parallel and perpendicular to the trenches and cribs. The data were compiled to form a 3-D representation of low resistivity values. Low resistivity, or high conductivity, is indicative of high ionic strength soil and porewater resulting from the migration of nitrate and other inorganic constituents through the vadose zone. High spatial density soil data from a single borehole, which included coincident nitrate concentrations, electrical conductivity, and Tc-99, were used to transform the electrical resistivity data into a nitrate plume. The plume was shown to extend laterally beyond the original boundaries of the waste site and, in one area, to depths that exceeded the characterization strategy. It is unknown whether the plume reached the water table, located approximately 104 meters below ground surface.
http://www.wmsym.org/abstracts/2006/pdfs/6238.pdf

Biogeochemical Mechanisms of Arsenic Mobilization in Haiwee Reservoir Sediments
Campbell, Kate Marie, Ph.D. dissertation, California Inst. of Technology, Pasadena, 2007

Naturally-occurring arsenic (As) in the Los Angeles Aqueduct, a major drinking water source for the City of Los Angeles, is removed by precipitating an amorphous iron (Fe) oxyhydroxide floc in the aqueduct waters. The floc is removed via sedimentation at Haiwee Reservoir, where the Fe- and As-rich sediments provide a field site for studying the mechanisms of As mobilization to sediment porewater. A gel-probe equilibrium sampler was developed to measure the porewater concentrations and As sorption behavior in Haiwee Reservoir sediments. The gels consisted of a polyacrylamide polymer matrix and were 92% water. Undoped (clear) gels were used to determine porewater composition, and hydrous ferric oxide (HFO)-doped gels were used to measure in situ As adsorption chemistry. Gels were placed in a plastic holder, covered with a membrane filter, and allowed to equilibrate with the sediment porewaters. This study combined data from the gel probe samplers, gravity cores, and lab studies to evaluate the biogeochemical processes governing As partitioning between the solid and aqueous phases. The gel probe device allowed for in situ observation of the effect of porewater chemistry on As adsorption. Arsenic was reduced from As(V) to As(III) in the upper layers of the sediment, but the change in redox state did not cause As to be mobilized into the porewaters. Arsenic mobilization occurred during reductive dissolution of Fe(III) oxides. Arsenate and Fe(III)

reduction were probably microbially mediated. Arsenic sorption onto the HFO-doped gels was inhibited at intermediate depths, possibly due to dissolved carbonate produced from organic carbon mineralization. The partitioning of As onto the sediment in this region may be primarily controlled by porewater chemistry, rather than sorption site availability. Deeper in the sediment column, the Fe(III) phase was partially transformed to carbonate green rust, possibly sequestering dissolved carbonate. In this region, As adsorption onto HFO-doped gels was controlled by dissolved phosphate. The accumulation of As in the porewater in this region may be due to lack of available surface adsorption sites on the sediment. Arsenic partitioning between solid and aqueous phases depends on microbially driven diagenetic processes, as well as porewater composition.
Several chapters of thesis available at http://etd.caltech.edu/etd/available/etd-12182006-102819/

Bioluminescent Bacterial Biosensors for the Assessment of Metal Toxicity and Bioavailability in Soils
Alkorta, I., L. Epelde, I. Mijangos, I. Amezaga, and C. Garbisu, Univ. of the Basque Country, Bilbao, Spain.
Reviews in Environmental Health, Vol 21 No 2, p 139-152, Apr/June 2006

Bioluminescence-based bacterial biosensors have been developed using genetically engineered microorganisms, constructed by fusing transcriptionally active components of metal resistance mechanisms to lux genes from naturally bioluminescent bacteria like Vibrio fischeri for the assessment of metal toxicity and bioavailability in polluted soils. Compared to chemical methods, bacterial biosensors present advantages in selectivity, sensitivity, simplicity, and low cost. Despite certain inherent limitations, bacterial bioluminescent systems have proven their usefulness in soils under laboratory and field conditions. The green-fluorescent, protein-based bacterial biosensors are applicable for determining with high sensitivity the bioavailability of heavy metals in soil samples.

Biosensor for Continuous Monitoring of Organophosphate Aerosols
Luckarift, H.R., G.R. Johnson, R. Greenwald, M. Bergin, and J.C. Spain.
AFRL-ML-TY-TP-2006-4581, ADA464371, 22 pp, Dec 2006

An enzyme-based monitoring system provides the basis for continuous sampling of organophosphate contamination in air. The enzymes butyrylcholinesterase (BuChE) and organophosphate hydrolase (OPH) are stabilized by encapsulation in biomimetic silica nanoparticles, entrained within a packed bed column. The resulting immobilized enzyme reactors (IMERS) were integrated with an impinger-based aerosol sampling system for collection of chemical contaminants in air. The sampling system was operated continuously, and organophosphate detection was performed in real time by single wavelength analysis of enzyme hydrolysis products. The resulting sensor system detects organophosphates based on either enzyme inhibition (of BuChE) or substrate hydrolysis (by OPH). The system proved suitable for detection of a range or organophosphates, including paraoxon, demeton-S, and malathion. The detection limits of the IMERs for specific organophosphates are presented and discussed. [Note: This version is a pre-print. The paper also appears as "Biosensor System for Continuous Monitoring of Organophosphate Aerosols," Biosensors and Bioelectronics, 2007]
http://handle.dtic.mil/100.2/ADA464371

Combination of Neural Network and SBFM Algorithm for Monitoring VOCs Distribution by Open Path FTIR Spectrometry
Ren, Y, Y. Li, B. Yu, J. Wang, and L.-P. Hu.
Instrumentation Science & Technology, Vol 35 No 1, 1-14, Feb 2007

A combination of artificial neural network (ANN) modeling and smooth basis function minimization (SBFM) algorithm were applied to open path Fourier transform infrared spectroscopy (OP-FTIR) for monitoring VOC concentration distributions in the air. ANN modeling provided analysis of the measured mixture spectra containing chloroform, methanol, and methylene chloride, and then the SBFM algorithm was used to reconstruct each component's concentration distribution. The peak concentration locations and maximum concentration for three components are reconstructed accurately. The methodology presented in this paper has significant importance in detecting leaking source spot and monitoring airborne VOCs transport in chemical industry workplaces.

Calibration Transfer Among Sensor Arrays Designed for Monitoring Volatile Organic Compounds in Indoor Air Quality
Wolfrum, E.J., R.M. Meglen, D. Peterson, and J. Sluiter.
IEEE Sensors Journal, Vol 6 No 6, p 1638-1643, Dec 2006

Abstract not available.

Comparison of Geoprobe® PRT and AMS GVP Soil-Gas Sampling Systems with Dedicated Vapor Probes in Sandy Soils at the Raymark Superfund Site
DiGiulio, D., C. Paul, and B. Scroggins (U.S. EPA, Ada, OK); R. Cody and R. Willey (U.S. EPA, Boston, MA); S. Clifford (U.S. EPA, North Chelmsford, MA); R. Mosley (U.S. EPA, Research Triangle Park, NC); A. Lee and K. Christensen (Xpert Design and Diagnostics, LLC, Stratham, NH); R. Costa (The Shaw Group Inc., Ada, OK).
EPA 600-R-06-111, 79 pp, Nov 2006

This report describes the results of an investigation conducted to assist EPA's New England Regional Office in evaluating vapor intrusion in homes and a commercial building near the Raymark Superfund Site in Stratford, CT. Specifically, a study was conducted to compare results of soil-gas sampling using dedicated vapor probes; a truck-mounted direct-push technique, the Geoprobe® Post-Run-Tubing system; and a hand-held rotary hammer technique, the AMS Gas Vapor Probe kit. Testing revealed some statistically significant differences; however, the magnitude of variation was similar to that due to spatial variability on the scale of testing (1 m). For practical purposes, all three sample systems were considered approximately equivalent. This investigation should provide confidence that the PRT and GVP sample systems are satisfactory for collecting soil-gas samples in sandy soils, such as those present near the Raymark site, to evaluate the potential for vapor intrusion.
http://www.epa.gov/ada/download/reports/600R06111/600R06111.pdf

Computer Aided Design of Tailor-Made Biosensors for Following the Fate of Arsenic in Nature
Batzias, Fragiskos, Univ. of Piraeus, Piraeus, Greece.
Protection 2006: Proceedings of Protection and Restoration of the Environment VIII, Chania, Crete, Greece, 3-7 July 2006. Scientific References COSMOS, 2006

A computer-aided design of tailor-made biosensors is proposed for following the fate of arsenic (As) species at the local level in real time. The key component of the procedure for biosensors design and selection is the combination of a decomposition/recomposition mechanism and multi-criteria analysis. The proposed solution appears to be feasible and comparable in cost to conventional sampling and laboratory testing methods.
http://www.ath.aegean.gr/srcosmos/showpub.aspx?aa=8494

Cone-Based Electrical Resistivity Tomography
Pidlisecky, Adam, Ph.D. dissertation, Stanford University, 147 pp, May 2006

Determining the 3-D spatial distribution of subsurface properties is a critical part of managing the cleanup of contaminated sites. Noninvasive methods have the advantage of avoiding contact with and spreading the contaminants. The author has developed a minimally invasive technology that provides information about the 3-D distribution of electrical conductivity. This new technique, cone-based electrical resistivity tomography (C-bert), integrates the existing technologies of resistivity cone penetration testing (RCPT) with electrical resistivity tomography. The development of C-bert included the creation of new software and modeling algorithms, the design of field equipment, field testing, and processing and interpretation of the resulting data.
http://pangea.stanford.edu/research/enviro/docs/Pidlisecky-Thesis_Stanford2006.pdf

Cone-Based Electrical Resistivity Tomography
Pidlisecky, A., R. Knight, and E. Haber.
Geophysics, Vol 71 No 4, p G157-G167, 2006

A field study (Kidd 2) has successfully demonstrated that cone-based electrical resistivity tomography (C-bert) data can be used to obtain 3-D images in the near subsurface using electrical conductivity. The equipment used for the survey required minor modifications of existing resistivity cone penetration testing (RCPT) systems. Interpretation of the data, however, required the development of a cone-effect correction, which in turn required a computationally efficient solution to the forward problem. An iteratively determined boundary conditions (IDBC) approach was developed to facilitate this correction, allowing the forward problem to be solved faster than with a fully parameterized approach. The use of IDBC extends beyond simply solving for the cone effect; it can be used as an effective solver for the general Poisson's equation. Although the pilot study collected only five C-bert data sets, tens of data sets could be obtained easily in a full-scale field survey. The RCPT logs associated with each of these C-bert data sets are not only valuable for building an accurate starting model, but also provide the potential to generate more informed regularization operators for inversions. In over-parameterized inverse problems, some a priori knowledge must be injected to solve them. A priori knowledge, based on in situ, site-specific measurements, is more desirable than derivative type filters, but in general, these measurements are difficult to obtain; however, the co-located data acquired during the C-

bert process serve this purpose. The relatively simple layered structure at the Kidd-2 site did not allow a full demonstration of the potential benefits of C-bert, but a synthetic example illustrates the ability of C-bert to determine conductivity values in regions that are not readily accessible to other forms of measurement.
http://pangea.stanford.edu/research/enviro/papers/Pidlisecky,%20Knight%20and%20Haber%20(2006).pdf

Cost Effective Passive Sampling Device for Volatile Organic Compounds Monitoring
Thammakhet, C., V. Muneesawang, P. Thavarungkul, and P. Kanatharan.
Atmospheric Environment, Vol 40 No 24, p 4589-4596, Aug 2006

A laboratory-built passive sampler was developed as a simple and cost-effective device for monitoring VOCs like benzene, toluene and xylene (BTX). Common screw-cap glass bottles packed with 75 mg of activated Tenax TA were used as passive samplers. After exposure to a real sample, the adsorbent was desorbed using a lab-built thermal desorption device. The analytes were purged to fill a sampling loop and then injected by a gas sampling valve to a gas chromatograph with a flame ionization detector. The system was calibrated by BTX standard gas and the linear regression coefficient of greater than 0.99 was obtained with detection limits 0.3, 0.2 and 0.7 mg/m3 for benzene, toluene and xylene, respectively. The method was implemented for the monitoring of BTX at 10 gasoline stations in Hat Yai, Thailand.
http://www.aseanenvironment.info/Abstract/43004855.pdf

Data Acquisition and Interpretation Strategies for Monitored Natural Attenuation
Martus, P. (URS Canada Inc., Vancouver, BC); P. Blum (Eberhard-Karls-Univ. of Tuebingen, Germany); R. Melzer (URS Deutschland GmbH, Wennigsen, Germany).
Sea to Sky Geotechnique 2006: 59th Canadian Geotechnical Conference & 7th Joint CGS/IAH-CNC Groundwater Specialty Conference, 1-4 October 2006, Vancouver, BC, Canada. p 1625-1631, 2006

Monitored natural attenuation (MNA) is accepted in a growing number of industrialized countries as an approach worthy of consideration for contaminated site remediation. Practical experience with MNA has shown that site conditions are often more complex in fact than in theory, requiring considerable understanding of the processes that govern NA. Case studies are presented to illustrate the application of novel monitoring tools, such as compound-specific isotope analysis on C-13/C-12, signature metabolites analysis, and redox-sensitive tapes, which can be used to evaluate whether the contaminants of concern are actually (bio)degraded and to what extent. These tools have the potential to provide more reliable field quantification of degradation and improved investigation and assessment of small-scale biogeochemical processes.
http://www.uni-tuebingen.de/zag/members/blum/downloads/Martus_etal%20_2006_Vancouver.pdf

Delineation of Capture Zones in Groundwater Aquifers As a Tool for the Application of the "Polluter-Pays" Principle

Theodossiou, N. and P. Latinopoulos (Aristotle Univ. of Thessaloniki); G.P. Karatzas and E.A Maria (Technical Univ. of Crete, Hania).

Protection 2006: Proceedings of Protection and Restoration of the Environment VIII, Chania, Crete, Greece, 3-7 July 2006. Scientific References COSMOS, 8 pp, 2006

"The polluter pays" is one of the main thrusts introduced in the European Union Environmental Liability Framework Directive 2004/35/EC. According to this principle, the persons or activities responsible for any damage or negative impact on environmental systems must be charged with the cost of rehabilitation. The main problem in the application of this principle is the weakness of proof of the causal link between the environmental damage and the activity that has caused it in cases of diffuse pollution or in cases where more than one polluter source is involved. Acquiring this proof is an essential condition for the correct application of the principle and the fair apportionment of liability to the polluters in the frame of the judicial process. In complex environmental systems, such as a groundwater aquifers, the application of such a principle is not easy because many similar activities may occur in the same area. The authors present a field application for the delineation of capture zones in groundwater aquifer systems to determine the source of pollutants. This paper also introduces the effects of the uncertainty of the main groundwater system properties to determine the degree of validity of the final decision. The physical system is represented using a 3-D groundwater flow and mass transport numerical simulator.

http://www.ath.aegean.gr/srcosmos/showpub.aspx?aa=8148

Detailed Vertical and Lateral Delineation of Redox Zones in Contaminant Plumes Using Redox-Sensitive Tapes (RST)

Blum, P. (Eberhard-Karls Univ. Tuebingen, Germany); F.D. Oeste (gM-Ingenieurbuero, Kirchhain, Germany); R. Melzer (URS Deutschland GmbH, Hannover, Germany); P. Martus (URS Canada Inc., Vancouver, BC).

Eos, Transactions of the AGU, Vol 87 No 52, Abstract B53B-0345, 2006

Innovative redox-sensitive tape (RST) has been developed for a detailed vertical and lateral delineation of redox zones in contaminated aquifers. The tape consists of a synthetic textile 2 cm wide and coated with reactive manganese dioxide minerals. RST is submerged into existing monitoring wells for approximately one month, which is sufficient time to allow for a reaction of the mineral coating with ground water. RST can be used to investigate four different redox zones in contaminated aquifers: Mn(II)-oxidizing, Mn(IV)-reducing, Fe(III)-reducing, and sulfate-reducing. Two RST case studies are presented. RST investigations on a coal tar-contaminated site allowed for a precise lateral and vertical delineation of the contaminant plume via the existing monitoring well network. RST investigations on a BTEX-contaminated site showed good correlation of RST data with hydrochemical data in sampled wells. Repeated application of RST facilitated an assessment of the plume dynamics. RSTs have the potential to become an integral part of a data acquisition strategy for monitored natural attenuation.

Detectability of Chemicals in 3D Flow by Microsensor Arrays
Wu, Rong and Nikolaos D. Katopodes, Univ. of Michigan, Ann Arbor.
Protection 2006: Proceedings of Protection and Restoration of the Environment VIII, Chania, Crete, Greece, 3-7 July 2006. Scientific References COSMOS, 8 pp, 2006

A novel technology has been developed and applied for the automatic detection and real-time control of chemical clouds in 3-D channel flow. Microsensor arrays capable of detecting a broad menu of chemical and biological agents are installed at strategic locations in the channel. Gradient information is obtained by use of the Adjoint Equations, so optimization of the control actions is achieved with the highest possible efficiency. The sensor arrays detect all changes effected by the control and report them to the control model, which advances the process over the next finite horizon. Sensing, optimization and feedback is achieved in a time period shorter than the prediction horizon, so the process can proceed in real time.
http://www.ath.aegean.gr/srcosmos/showpub.aspx?aa=8137

Determination and Quantification of Non-Aqueous Phase Liquid Mixtures in Environmental Media
Rucker, Gregory G., Washington Savannah River Company, Aiken, SC.
Proceedings of the Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, 2006. WSRC-STI-2006-00202, 16 pp, 2006

It is important to recognize the presence of nonaqueous-phase liquids (NAPLs) in soils at a waste site to design and construct a successful remediation system. NAPLs often manifest as a complex, multi-component mixture of organic compounds that can occur in environmental media, such as vadose zone soil, where the mixture will partition and equilibrate with soil particles, pore vapor, and pore water. Complex organic mixtures can complicate the determination and quantification of NAPL in soil due to inter-media transfer. NAPL thresholds can also change because of a mixture of physical properties that can disguise the presence of NAPL. A unique analytical method and copyrighted software have been developed at DOE's Savannah River site that facilitates solution of this problem. The analytical method uses a classic chemistry approach and applies the principals of solubility limit theory, Raoult's Law, and equilibrium chemistry to derive an accurate estimation of NAPL presence and quantity. The method is unique because it calculates an exact result that is mass balanced for each physical state and chemical mixture component, and predicts mixture characteristics. The method also is unique in that the solution can be calculated on both a wet weight and dry weight basis. The software contains physical parameters for 300 chemicals in a database that self-loads into the model. The method accommodates up to 20 different chemicals in a multi-component mixture analysis. A robust data display shows important parameters of the components and mixture, including NAPL thresholds for individual chemical components within the mixture, mass distribution in soil for each physical state, molar fractions, density, vapor pressure, solubility, mass balance, media concentrations, residual saturation, and modest graphing capabilities. This method and software simplify otherwise tedious calculations and eliminate guesswork for site characterizations.
http://sti.srs.gov/fulltext/WSRC-STI-2006-00202.pdf

Development of a Real-Time PCR Assay for the Quantification of Polaromonas sp. Strain JS666 in Soil
Jennings, L.K. (Cornell Univ.), C. Sausville-Giddings, J.M. Gossett, and N.V. Coleman.
The Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, (Monterey, CA; May 2006): Book of Abstracts. Battelle Press, Columbus, OH. 2006

*Polaromonas sp*. Strain JS666 has been shown to aerobically degrade 1,2-dichloroethene (1,2-DCE) using 1,2-DCE as its sole carbon source. The authors have developed a probe to test for JS666 in the event that site managers might want to assess the potential for allowing anaerobic degradation of PCE/TCE near the source zone with the potential for aerobic degradation of 1,2-DCE further downgradient.

Development of a Solid-Phase Microextraction-Based Method for Sampling of Persistent Chlorinated Hydrocarbons in an Urbanized Coastal Environment
Zeng, E.Y., D. Tsukada, and D.W. Diehl.
Environmental Science & Technology, Vol 38, p 5737-5743, 2004

This paper describes the development of a solid-phase microextraction (SPME)-based sampling method employing a poly(dimethylsiloxane) (PDMS)-coated fiber as the sorbent phase. Laboratory-calibrated PDMS-coated fibers were used to construct SPME samplers, and field tests were conducted at three coastal locations to determine the equilibrium sampling time and to compare the efficacy of the SPME samplers with that of an Infiltrex 100 water pumping system. DDE components were consistently detected in the SPME samples among 42 polychlorinated biphenyl congeners and 17 chlorinated pesticides targeted. SPME samplers deployed at two locations with moderate and high levels of contamination for 18 and 30 d, respectively, attained statistically identical concentrations of p, p'-DDE and o, p'-DDE. Study results indicate that equilibrium could be reached within 18 to 23 d. The concentrations obtained with the SPME samplers and the Infiltrex 100 system were virtually identical. The field tests not only reveal the advantages of the SPME samplers compared to the Infiltrex 100 system and other integrative passive devices but also indicate the need to improve the sensitivity of the SPME-based sampling technique.
http://www.aseanenvironment.info/Abstract/41011664.pdf

Development and Use of Integrated Microarray-Based Genomic Technologies for Assessing Microbial Community Composition and Dynamics
Zhou, J., L. Wu, T. Gentry, C. Schadt, Z. He, and X. Li.
Annual Environmental Remediation Sciences Program PI Meeting, April 3-5, 2006, Warrenton, VA. CONF-ERSP2006-69, Poster presentation, 2006

A 50-mer-based oligonucleotide microarray was developed to monitor microbial populations and their processes. The microarray is based on known genes and pathways involved in biodegradation, metal resistance and reduction, denitrification, nitrification, nitrogen fixation, methane oxidation, methanogenesis, carbon polymer decomposition, and sulfate reduction. The array contains approximately 2,000 unique and group-specific probes with <85% similarity to their non-target sequences. Based on artificial probes, results showed that at hybridization conditions of 50 degrees C and 50% formamide, the 50-mer microarray hybridization can differentiate sequences having <88% similarity. Specificity tests with representative pure cultures indicated that the designed probes on the arrays appeared to be specific to their

corresponding target genes. Application of this microarray to naphthalene-amended enrichments and soil microcosms demonstrated that composition of the microflora varied depending on incubation conditions. While the naphthalene-degrading genes from Rhodococcus-type microorganisms were dominant in enrichments, the genes involved in naphthalene degradation from Gram-negative microorganisms such as Ralstonia, Comamonas, and Burkholderia were most abundant in the soil microcosms (as well as those for polyaromatic hydrocarbon and nitrotoluene degradation). Although naphthalene degradation is widely known and studied in Pseudomonas, Pseudomonas genes were not detected in either system. This microarray is being applied to the study of several different microbial communities and processes. One project involves the monitoring of the development and dynamics of the microbial community of a fluidized bed reactor (FBR) used for reducing nitrate and the other project monitors microbial community responses to stimulation of uranium reducing populations via ethanol donor additions in situ and in a model system. Great improvements to probe design methods were made by the development of a new computer program, CommOligo. CommOligo designs unique and group-specific oligo probes for whole-genomes, metagenomes, and groups of environmental sequences and uses a new global alignment algorithm to design single or multiple probes for each gene or group.
http://www.lbl.gov/ERSP/generalinfo/pi_meetings/PI_mtg_04/04_PI_Meeting_pdf/posters/zhou_04poster.pdf

Dissolved Hydrogen Analyzer: Cost and Performance Report
Lebron, Carmen, Naval Facilities Engineering Service Center, Port Hueneme, CA, et al.
NTIS: ADA451214, 40 pp, May 2006

Monitored natural attenuation (MNA) is a cost-effective remediation approach that is applicable to many sites. This remedial strategy has been embraced by DoD for sites contaminated with petroleum hydrocarbons, chlorinated hydrocarbons, and metals as an alternative to ground-water pump and treat. Determining MNA's technical applicability for a given site is based on sampling and analysis, data evaluation and modeling, and long-term monitoring. The evaluated parameters include concentrations of contaminants, electron acceptors, and electron donors (e.g., hydrogen). These concentrations in combination with hydrogeologic, soil, and microbial characteristics are used to assess the fate and transport of contaminants and the potential for natural attenuation. Concentrations of electron acceptors or their reduced products are typically used to (1) identify terminal electron accepting processes (TEAP) responsible for contaminant biodegradation occurring in specific areas of a contaminant plume, and (2) quantify assimilative capacity of an aquifer for contaminants of concern. TEAPs influence the in situ transformation of many pollutants in part by their impact on dissolved hydrogen (DH) concentrations in ground water. Identification of TEAPs and DH concentrations can indicate specific degradation patterns of contaminants, such as chlorinated hydrocarbons and benzene. Although DH measurements are known to be a useful tool to delineate the TEAPs in aquifers, this parameter is not measured in the field because of the expensive analytical equipment required. This report describes the demonstration at three DoD sites of a portable DH analyzer, a novel analytical technology developed by Camp Dresser & McKee, Inc., to help determine natural attenuation potential. [Note: This document updates the information presented in the 2004 cost and performance report for the dissolved hydrogen analyzer.]
http://handle.dtic.mil/100.2/ADA451214

Double Pulse, Calibration-Free Laser-Induced Breakdown Spectroscopy: A New Technique for In Situ Standard-Less Analysis of Polluted Soils
Corsi, M.; G. Cristoforetti.; M. Hidalgo; S. Legnaioli; V. Palleschi (CNR, Pisa, Italy); A. Salvetti, E. Tognoni; and C. Vallebona.
Applied Geochemistry, Vol 21 No 5, p 748-755, 2006

Laser-induced breakdown spectroscopy is a promising technique for in situ environmental analysis. The potential of this technique for accurate quantitative analysis could be greatly improved using an innovative experimental setup that is based on the use of two laser pulses suitably retarded and then analyzing the results with a procedure that overcomes the problems related to matrix effects. A new mobile instrument for soil analysis, developed at the Applied Laser Spectroscopy Laboratory in Pisa, is presented with some experimental results.

A Dynamic Two-Dimensional System for Measuring Volatile Organic Compound Volatilization and Movement in Soils
Allaire, S.E., S.R. Yates, F.F. Ernst, and J. Gan.
Journal of Environmental Quality, Vol 31, p 1079-1087, 2002

For a better understanding of atmospheric emission of toxic volatile compounds, chemical movement and distribution in the soil profile should be simultaneously monitored with its volatilization. A 2-D rectangular soil column was constructed and a dynamic sequential volatilization flux chamber was attached to the top of the column. The flux chamber was connected through a manifold valve to a gas chromatograph (GC) for real-time concentration measurement. Gas distribution in the soil profile was sampled with gas-tight syringes at selected times and analyzed with a GC. A pressure transducer was connected to a scanivalve to automatically measure the pressure distribution in the gas phase of the soil profile. The system application was demonstrated by packing the column with a sandy loam in a symmetrical bed–furrow system. A 5-h furrow irrigation was started 24 h after the injection of a soil fumigant, propargyl bromide. The experience showed the importance of measuring lateral volatilization variability, pressure distribution in the gas phase, chemical distribution between the different phases (liquid, gas, and sorbed), and the effect of irrigation on the volatilization. This versatile system can be modified and used to compare management practices; estimate concentration/time indexes for pest control; study chemical movement, degradation, and emissions; and test mathematical models.
http://jeq.scijournals.org/cgi/content/full/31/4/1079?ijkey=b7a1bc75fa5f27c96ae17b8b09efa589981b63e5

Ecotoxicity Monitoring of Hydrocarbon-Contaminated Soil During Bioremediation: A Case Study
Hubalek, T., S. Vosahlova, V. Mateju, N. Kovacova, and C. Novotny, Academy of Sciences of the Czech Republic, Prague.
Archives in Environmental Contamination and Toxicology, Vol 52 No 1, p 1-7, Jan 2007

The ecotoxicity of hydrocarbon-contaminated soil from a brownfield site was evaluated during a 17-month biodegradation pilot test. The initial concentration of total petroleum hydrocarbons (TPHs) in the soil was 6,380 ug/g dry weight. Soil (200 kg) was inoculated with 1.5 L of the bacterial preparation GEM-100 containing Pseudomonas sp. and Acinetobacter sp. strains adapted to diesel fuel. The concentration of TPHs in the soil decreased by 65.5% after bioremediation. Different organisms were used for ecotoxicity evaluation, and plants, earthworms, and crustaceans provided the most sensitive bioassays. The highest toxicity was detected in the first period of bioremediation, but certain toxic effects were detectable during the whole bioremediation process. The contact tests performed directly on soil samples were shown to be a better tool for ecotoxicity evaluation of hydrocarbon-contaminated soil than the tests performed on soil elutriates. The ecotoxicity measured by the test responses did not always correlate with the decrease in TPH concentrations in the soil during bioremediation.

Effect of Vapor Source-Building Separation and Building Construction on Soil Vapor Intrusion as Studied with a Three-Dimensional Numerical Model
Abreu, L.D.V and P.C. Johnson, Arizona State Univ., Tempe.
Environmental Science & Technology, Vol 39, p 4550-4561, 2005

A three-dimensional numerical model of the soil vapor-to-indoor air pathway was developed. The tool predicts the relationships between the vapor attenuation coefficient, R (indoor air concentration/ source vapor concentration), and vapor source-building lateral separation, vapor source depth, and building construction characteristics (depth of building foundation) for nondegrading chemicals. The model allows for diffusive and advective transport, spatially distributed foundation cracks, and transient indoor and ambient pressure fluctuations. Simulations show a decreasing R value with increasing lateral separation from the source. For example, when a 30 m by 30 m source located 8 m below ground surface is displaced from the edge of the building by 20 m, R falls by 2 orders of magnitude. When the 30 m by 30 m source is only 3 m deep, the R falls by about 5 orders of magnitude when the source is moved laterally by 20 m. In addition, it was found that overpressurizing a building to create outflow on the order of 1-3 L/min, reduced indoor air intrusion by over 5 orders of magnitude relative to intrusion rates at underpressurized buildings. The simulations assume homogeneous soil properties, nondegrading chemicals, steady source concentrations and building underpressurizations.

Electrochemical Sensor for Organophosphate Pesticides and Nerve Agents Using Zirconia Nanoparticles as Selective Sorbents
Liu, Guodong and Yuehe Lin, PNNL, Richland, WA.
Analytical Chemistry, Vol 77 No 18, p. 5894-5901, 2005

An electrochemical sensor for detection of organophosphate (OP) pesticides and nerve agents using zirconia ($ZrO_2$) nanoparticles as selective sorbents is constructed by depositing zirconia nanoparticles electrodynamically onto a polycrystalline gold electrode by cyclic voltammetry. Because of the strong affinity of zirconia for the phosphoric group, nitroaromatic OPs strongly bind to the $ZrO_2$ nanoparticle surface. Square-wave voltammetric (SWV) analysis was used to monitor the amount of bound OPs and provide simple and quick quantitative methods for nitroaromatic OP compounds. The sensor surface can be regenerated by successively running SWV scanning. The detection limit was improved from 3 ng/mL to 1 ng/mL by using 10-min adsorption time. The promising stripping voltammetric performances open new opportunities for fast, simple, and sensitive analysis of OPs in environmental and biological samples and potentially to a widespread use of electrochemical sensors to detect OP contaminants.

Encapsulation of Organophosphorus Acid Anhydrolase (OPAA) in Nanostructured Materials for the Detection and Decontamination of Chemical Warfare Agents
Ong, Kate K., Ph.D. dissertation, Drexel University, 235 pp, May 2006

A novel non-surfactant-templated pathway as developed at Drexel University offers a simple, biocompatible, environmentally-friendly method to produce optically transparent, mesoporous materials with controllable pore size from 2 to 12 nanometers. Enzymes—e.g., horseradish peroxidase, glucose oxidase, and alcohol dehydrogenase—have been successfully encapsulated into mesoporous materials using various non-surfactant molecules as templates. This dissertation expands upon the library of encapsulated mesoporous materials for government and industrial applications. The organophosphorus acid anhydrolase (OPAA) enzyme was studied for its unique capability to detoxify toxic organophosphorus compounds, especially the G-type nerve agents. Given the potential for acts of terrorism, a universal chemical decontaminant and practical sensor is needed. OPAA was encapsulated in mesoporous silica (as well as organically modified silica) to enhance enzyme stability under various harsh conditions. Chapter 2 provides an overview of the experimental methods employed to accomplish the tasks in this study. Chapters 5 and 6 describe the testing of the application and reusability of the OPAA-encapsulated mesoporous materials in both aqueous and mixed aqueous/organic solvent systems. The application of gold-doped mesoporous materials as a potential active substrate for the surface-enhanced Raman spectroscopic detection of cyanide in aqueous systems is highlighted.

http://dspace.library.drexel.edu/bitstream/1860/895/1/Ong_Kate.pdf

Environmental Applications of Membrane Introduction Mass Spectrometry
Ketola, R.A. (VTT Processes, VTT, Finland); T. Kotiaho (Univ. of Helsinki, Finland); M.E. Cisper (Los Alamos National Lab, Los Alamos, NM); T.M. Allen (Isotag Technology, Inc., Los Alamos, NM).
Journal of Mass Spectrometry, Vol 37, p 457-476, 2002

This review highlights the versatility of membrane introduction mass spectrometry (MIMS) in environmental applications, summarizes the measurements of environmental volatile organic compounds accomplished using MIMS, presents developments in the detection of semi-volatile organic compounds, and forecasts possible future directions of MIMS in environmental applications.

http://www.analyticalresearchsystems.it/Risorse/mims%20rewiew.pdf

Environmental Odours Assessment from Waste Treatment Plants: Dynamic Olfactometry in Combination with Sensorial Analysers 'Electronic Noses'
Littarru, Paolo, Univ. of Rome 'La Sapienza', Rome, Italy.
Waste Management, Vol 27 No 2, 2007

After an overview of the legal criteria of odor nuisance in Italy, the authors describe an application of dynamic olfactometry in combination with determinations made using electronic noses. The coordination of the two approaches permits optimization of the advantages offered by both methods to the measurable and objective evaluation of an odor nuisance from waste treatment plants and chemical plants.

Enzyme-Encapsulated Silica Monolayers for Rapid Functionalization of a Gold Surface
Luckarift, H.R., G.R. Johnson, S. Balasubramanian, S. Paliwal, and A.L. Simonian.
Colloids and Surfaces B: Biointerfaces, Vol 58 No 1, p 28-33, 1 July 2007 [NTIS: ADA459758]

A simple and rapid method for the deposition of amorphous silica onto a gold surface is reported. The method is based on the ability of lysozyme to mediate the formation of silica nanoparticles. A monolayer of lysozyme is deposited via non-specific binding to gold. The lysozyme then mediates the self-assembled formation of a silica monolayer. The silica formation occurs on a surface plasmon resonance (SPR) gold surface and is characterized by SPR spectroscopy. The silica layer increases the surface area significantly compared to the gold substrate and is directly compatible with a detection system. The maximum surface concentration of lysozyme was found to be a monolayer of 2.6 ng/nm$^2$, which allowed the deposition of a silica layer of a further 2 ng/mm$^2$. For additional surface functionalization, the silica was also shown to be a suitable matrix for immobilization of biomolecules. The encapsulation of organophosphate hydrolase (OPH) was demonstrated as a model system. The silica forms at ambient conditions in a reaction that allows the encapsulation of enzymes directly during silica formation. OPH was successfully encapsulated within the silica particles and a detection limit for the substrate, paraoxon, using the surface-encapsulated enzyme was found to be 20 uM.
http://handle.dtic.mil/100.2/ADA459758

Equilibration-Based Preconcentrating Minicolumn Sensors for Trace Level Monitoring of Radionuclides and Metal Ions in Water without Consumable Reagents
Egorov, Oleg B., M.J. O'Hara, and J.W. Grate.
Analytical Chemistry, Vol 78 No 15, p 5480-5490, 2006

A preconcentrating minicolumn containing a selective solid phase sorbent is used to remove analytes from solution as it is pumped through the column. On-column detection of the captured analytes using radiometric and spectroscopic methods was demonstrated for Tc99, Sr-90, and Cr+6. For trace level detection the sensor provides a steady state signal that is proportional to the sample analyte concentration. The theoretical underpinning of why the device works has been developed. The sensor behavior in experiments closely matches the theoretical predictions. This sensor is particularly attractive when the use of consumable reagents for sensor regeneration is undesirable. The sensor can be used for long term in situ monitoring. Tc-99 and Cr+6 in groundwater matrices were detected at 0.033 Bq/mL and levels below 50 ppb, respectively.

Evaluating the Use of Electrical Resistivity Imaging Technique for Improving CH4 and CO2 Emission Rate Estimations in Landfills
Georgaki, I. (Technological Educational Inst. of Crete Stavromenos, Heraklion, Greece); P. Soupios; N. Sakkas; F. Ververidis; E. Trantas; F. Vallianatos; T. Manios.
Protection 2006: Proceedings of Protection and Restoration of the Environment VIII, Chania, Crete, Greece, 3-7 July 2006. Scientific References COSMOS, 9 pp, 2006

To improve the estimation of surface gas emissions from landfills, a combination of geophysical and greenhouse gas measurement methodologies was evaluated. Based on 15 2-D electrical resistivity tomography (ERT) measurements, longitudinal cross-section images of the buried waste layers were developed, identifying place and cross-section size of organic waste

(OW), organic waste saturated in leachates (SOW), low-organic waste, and non-organic waste. $CH_4$ and $CO_2$ emission measurements were conducted using the static chamber technique along two tomographies: (a) in four different surface points across a high-emitting area, ERT#2, where different amounts of relatively fresh OW and SOW were detected and (b) across the oldest (at least 8 years old) cell in the landfill, ERT#6, with significant amounts of OW. Emission rates were found to be dependent on the age of the buried waste and also on surface accumulation of leachates (or water) detected at surface point 4 in ERT#2.
http://www.ath.aegean.gr/srcosmos/showpub.aspx?aa=8382

Evaluation of Emerging Contaminants of Concern at the South District Wastewater Treatment Plant Based on Seasonal Events, Miami-Dade County, Florida, 2004
Lietz, A.C., and M. T. Meyer.
U.S. Geological Survey Scientific Investigations Report 2006-5240, 38 pp, 2006

The U.S. Geological Survey, in cooperation with the Comprehensive Everglades Restoration Plan Wastewater Reuse Technology Pilot Project Delivery Team, initiated a study to assess the presence of emerging contaminants of concern in the South District Wastewater Treatment Plant influent and effluent using current wastewater-treatment methods.
http://pubs.usgs.gov/sir/2006/5240/

Extended Performance Handheld and Mobile Sensors for Remote Detection of Natural Gas Leaks
Frish, M.B., B.D. Green, R.T. Wainner, F. Scire-Scappuzzo, P. Cataldi, and M.C. Laderer.
PSI-1402/TR-1979, 88 pp, May 2005

This report summarizes work performed by Physical Sciences Inc. (PSI) to advance the state of the art of surveying for leaks of natural gas from transmission and distribution pipelines. The principal project goal was to develop means of deploying on an automotive platform an improved version of the handheld laser-based standoff natural gas leak detector previously developed by PSI and known as the Remote Methane Leak Detector (RMLD). A laser beam that interrogates the air for methane is projected from a spinning turret mounted upon a van. As the van travels forward, the laser beam scans an arc to the front and sides of the van to survey across streets and to building walls from a moving vehicle. When excess methane is detected within the arc, an alarm activates. PSI built and tested a prototype Mobile RMLD (MRMLD) intended to provide lateral coverage of 10 m and one lateral scan for every meter of forward motion at forward speeds up to 10 m/s. Using advanced detection algorithms developed as part of this project, the early prototype MRMLD, installed on the back of a truck, readily detected simulated gas leaks of 50 liters per hour. As a supplement to the originally planned project, PSI also participated in a DOE demonstration of several gas leak detection systems at the Rocky Mountain Oilfield Testing Center during September 2004. Using a handheld RMLD upgraded with the advanced detection algorithms developed in this project, the device within a moving vehicle readily detected leaks created along the 7.4 mile route of a virtual gas transmission pipeline.
http://www.osti.gov/energycitations/servlets/purl/840957-dB876y/native/

Fast-Track DRESSA: a Bioassay for Fast, Sensitive, and Selective Detection of Halogenated and Polycyclic Aromatic Hydrocarbons.
Maeda, S., N. Hiramatsu, Yao Jian, A. Kasai, M. Kitamura, and Meng YiMan, Univ. of Yamanashi, Tamaho, Yamanashi, Japan.
Analytical Biochemistry, Vol 337 No 1, p 84-88, 2005

DRESSA (dioxin-responsive-element-based sensing via secreted alkaline phosphatase) is a mammalian cell-based bioassay system that can detect dioxin and dioxin-like chemicals with high sensitivity. The authors describe an advanced method--"fast-track DRESSA"--that achieves fast, selective, and sensitive detection of dioxin and other toxic compounds. Via optimization of assay conditions on cell number and serum concentration, the fast-track DRESSA enabled detection of 0.5 pM 2,3,7,8-tetrachlorodibenzo-p-dioxin within 6 h. It also enabled detection of 10 pM 3-methylcholanthrene, 100 pM benzo[a]pyrene, and 100 pM beta-naphthoflavone within 6 to 16 h. By combination with the AhR antagonist a-naphthoflavone, nonspecific, false-positive responses could be eliminated. Because of its rapid response, ease of use, sensitivity, and specificity, fast-track DRESSA would be advantageous for high-throughput screening of dioxin and dioxin-like compounds in environmental samples.

Field Application of Partitioning Gas Tracer Test for Measuring Water in a Bioreactor Landfill
Han, B. and P.T. Imhoff (Univ of Delaware, Newark); R. Yazdani (Planning, Resources, and Public Works Department, Yolo County, Woodland, CA).
Environmental Science & Technology, Vol 41 No 1, p 277-283, 2007

Two field-scale partitioning gas tracer tests (PGTTs) were performed to evaluate the utility of the PGTT method for measuring water saturation and moisture content in a full-scale bioreactor landfill, where waste biodegradation resulted in elevated temperatures and significant landfill gas production. Average water saturation and moisture content were measured for waste volumes of approximately 20 cubic m and results were compared to gravimetric measurement of moisture content made on samples collected from the landfill. In the center of the landfill, the moisture content estimated from the PGTT was nearly identical to the gravimetric measurement of waste samples taken from the same region. PGTT-estimated moisture contents in a dry area of the landfill were much smaller and consistent with available gravimetric measurements. Biodegradation of tracers and temporal variations in landfill gas production were minimal and did not influence the tests. These field experiments demonstrate the utility of the PGTT method for measuring water saturation and estimating moisture content in bioreactor landfills with active waste degradation and generation of landfill gases; however, use of the PGTT to estimate the in situ moisture content requires estimates of the refuse porosity, dry bulk density, and temperature, which might limit its application.
http://www.aseanenvironment.info/Abstract/41014327.pdf

Field Portable and Autonomous Immunosensors for the Detection of Environmental Contaminants
Blake, D.A., H. Yu, E.A. James, X. Li (Tulane Univ., New Orleans, LA); R.C. Blake (Xavier Univ. of Louisiana, New Orleans).
Uranium in the Environment: Mining Impact and Consequences. Springer, ISBN: 978-3-540-28363-8, p 87-95, 2006

A monoclonal antibody that binds with high affinity to $UO_2^{2+}$ complexed with the chelator 2,9-dicarboxyl-1,10-phenanthroline was used to develop a sensor-based assay for $UO_2^{2+}$. The assay range for $UO_2^{2+}$ was 0.5 to 25 nM (0.12 to 6 ppb). The average coefficients of variation in the assay was 2.2%. The immunoassay results were comparable to those obtained using the kinetic phosphorescence assay. The versatility of this sensor platform was further demonstrated by the development of an immunoassay for caffeine.

Field Screening for Halogenated Volatile Organic Compounds: the New X-Wand™ HVOC Screening Device
Schabron, John F., Susan S. Sorini, and Joseph F. Rovani, Jr.
WRI 06-R009, 46 pp, 2006

Western Research Institute has developed new methodology and a test kit to screen soil or water samples for halogenated volatile organic compounds (HVOCs) in the field. The technology has been designated the X-Wand™ screening tool. The new device contains a heated diode sensor commonly used to detect leaks of refrigerants from air conditioners, freezers, and refrigerators. This sensor is selective to halogens but does not respond to volatile aromatic hydrocarbons, such as those in gasoline, and it is not affected by high humidity. The heated diode leak detectors have been modified to provide units with rapid response and enhanced sensitivity. The limit of detection for trichloroethene (TCE) in air is 0.1 mg/m$^3$ (S/N = 2), and the response to other HVOCS relative to TCE is similar. Variability between sensors and changes in a particular sensor over time can be compensated for by normalizing sensor readings to a maximum sensor reading at 1,000 mg/m$^3$ TCE. The TCE soil-screening method has been expanded to include application to water samples. Assuming complete vaporization, the detection limit for TCE in soil is about 1 ug/kg (ppb) for a 25-g sample in an 8-oz jar. The detection limit for TCE in water is about 1 ug/L (ppb) for a 25-mL sample in an 8-oz jar, which is comparable to quantitation limits of EPA GC/MS laboratory methods. An ASTM standard method has been approved as D 7203-05: Standard Test Method for Screening Trichloroethylene (TCE)-Contaminated Soil Using a Heated Diode Sensor.
http://www.osti.gov/energycitations/servlets/purl/887237-QcbtnI/887237.PDF

Functionalized Nanoparticles for Sensor Applications
Childs, K., S. Dirk, S. Howell, R.J. Simonson, and D. Wheeler.
SAND2005-6004, 35 pp, Sep 2005

Functionalized arrays of gold nanoparticles have been cross-linked with short conducting molecules that contain sensing functionalities. These bridging ligands modulate their conductivity based on their interaction with analytes. Once this functionalized nanoparticles organic ligand composite material is assembled between nanogaps electrodes, it will provide nanosized sensors that can be easily interrogated. These nanogap sensors will be engineered so that they can be fabricated into arrays of different sensor elements. This project consists of different requirements that must be met to enable the use of functionalized nanoparticles for sensor applications: (1) the appropriately functionalized nanoparticle, (2) a method to assemble the particles, and (3) the generation of a nanogap to contain the nanoparticles. The successes in each of these areas will be discussed as will the sensing behavior of the final films.
http://www.prod.sandia.gov/cgi-bin/techlib/access-control.pl/2005/056004.pdf

GC-Microchip APCI-MS and GC-Microchip APPI-MS Methods for the Analysis of PCBs
Luosujarvi, L.; M.-M. Karikko; M. Haapala; V. Saarela; S. Franssila; R. Ketola; R. Kostiainen; T. Kotiaho.
55th ASMS Conference on Mass Spectrometry, Indianapolis, Indiana, 3-7 June 2007

A microfabricated device based on a principle of atmospheric pressure chemical ionization (microchip APCI) and atmospheric pressure photo ionization (microchip APPI) consists of a silicon wafer and a glass wafer bonded together by anodic bonding. The microchip produces a confined plume that results in improved sensitivity compared to a commercial APCI source. The feasibility of microchip APCI and microchip APPI as an interface between a gas chromatograph and a mass spectrometer equipped with an API source has been proposed. A method for the analysis of selected polychlorinated biphenyls (PCBs) using microchip APCI with negative chemical ionization is presented and compared to a microchip APPI method. A capillary column from a gas chromatograph (HP 5890) was connected to a deactivated fused silica transfer line capillary, which was attached to the microchip. The transfer line was heated by a resistance wire heater and the microchip APCI by an integrated platinum heater. The nebulizer gas (nitrogen) was added to helium flow coming from the GC column to enhance the plume. An external corona discharge needle was situated in front of the microchip and the combination was placed in front of the orifice of the MS. A Bruker Esquire 3000+ ion trap was used for mass analysis. APPI is performed with the same setup, but instead of the corona needle a UV lamp and dopant is used for ionization. PCBs (28, 52, 101, 118, 138, 153 and 180) and the internal standard (hexachlorobenzene) showed characteristic [M-Cl+O]- ion isotopic patterns in negative corona discharge ionization. In general, ionization was observed to be efficient in negative ion mode for seven marker PCBs. The feasibility of GC-microchip APCI-MS was evaluated in respect to detection limits and repeatability. Highly chlorinated congeners have lower detection limits compared to less chlorinated congeners due to higher electron affinity and thus higher ionization efficiency. The detection limits obtained, 5 to 500 pg per injection, were at the same level previously reported for gaseous PCB samples with corona discharge ionization.

GeoChip: A Comprehensive Microarray for Investigating Biogeochemical, Ecological, and Environmental Processes
He, Z., T.J. Gentry, C.W. Schadt, L. Wu, J. Liebich, S.C. Chong, W. Wu, B. Gu, P. Jardine, C. Criddle, and J. Zhou.
The ISME Journal, Vol 1 No 1, p 67-77, 2007

The detection, characterization, and quantification of microorganisms in natural settings is very challenging, and linking microbial diversity to ecosystem processes and functions is even more difficult. A novel comprehensive microarray--GeoChip--has been developed. GeoChip 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. The GeoChip was used successfully for tracking the dynamics of metal-reducing bacteria and associated communities for an in situ bioremediation study. This is the first comprehensive microarray available for 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. It is particularly useful for providing direct linkages of microbial genes/populations to ecosystem processes and functions.
http://www.nature.com/ismej/journal/v1/n1/full/ismej20072a.html

Geochemical Characterization of Mine Waste, Mine Drainage, and Stream Sediments at the Pike Hill Copper Mine Superfund Site, Orange County, Vermont
Piatak, N.M., R.R. Seal II, J.M. Hammarstrom, R.G. Kiah, J.R. Deacon, M. Adams, M.W. Anthony, P.H. Briggs, and J.C. Jackson.
U.S. Geological Survey, Scientific Investigations Report 2006-5303, 131 pp, 2006

The Pike Hill Copper Mine Superfund Site in the Vermont copper belt consists of the abandoned Smith, Eureka, and Union mines, all of which exploited Besshi-type massive sulfide deposits. The site was listed on U.S. EPA's National Priorities List in 2004 due to aquatic ecosystem impacts. This study was intended to be a precursor to a formal remedial investigation by EPA, and it focused on the characterization of mine waste, mine drainage, and stream sediments. A related study investigated the effects of the mine drainage on downstream surface waters. The potential for mine waste and drainage to have an adverse impact on aquatic ecosystems, on drinking- water supplies, and to human health was assessed on the basis of mineralogy, chemical concentrations, acid generation, and potential for metals to be leached from mine waste and soils. The results were compared to those from analyses of other Vermont copper belt Superfund sites, the Elizabeth Mine and Ely Copper Mine, to evaluate if the waste material at the Pike Hill Copper Mine was sufficiently similar to that of the other mine sites that USEPA can streamline the evaluation of remediation technologies. Mine-waste samples consisted of oxidized and unoxidized sulfidic ore and waste rock, and flotation-mill tailings.
http://pubs.usgs.gov/sir/2006/5303/

Grand Plaza Site Investigation Using the Triad Approach and Evaluation of Vapor Intrusion
U.S. EPA, National Risk Management Research Laboratory, Cincinnati, OH.
EPA 540-R-07-002, 86 pp, Sep 2006

The Triad approach was implemented to characterize the extent of soil, ground-water, and soil-gas contamination by volatile organic compounds (VOCs) at a commercial brownfield site. The characterization data were used to assess impact on indoor air from vapor intrusion. From Geoprobe™ borings, 77 soil samples, 28 ground-water samples, and 10 soil-gas samples were collected and analyzed on site by EPA Method 8265 (SW-846) for direct sampling ion trap mass spectrometry. Additional Method 8260b and TO-15 analyses were performed on approximately 10% of the samples by off-site laboratories. Tetrachloroethene (PCE), trichloroethene, and cis-1,2-dichloroethene were detected in all media, with PCE the prevalent compound. The on-site analyses for PCE were 22% higher than the off-site analyses for methanol extracts from soil samples. For the shallow soil-gas samples, the on-site results for PCE agreed with the off-site analyses within about one order of magnitude for the sample pairs where PCE was present at concentrations >10 ppbv. The off-site results for the sub-slab soil-gas samples were several orders of magnitude higher than the on-site results, perhaps due to limitations in the on-site sampling and analytical approach at these high concentrations. The geology was interpreted from the boreholes and logs from previously drilled ground-water monitoring wells. All data indicated the presence of a small PCE hot spot, roughly 40 ft by 40 ft. The hot spot was shallow (less than 10 feet below ground surface [bgs]) on top of a low permeability clay under the southwestern edge of a building that formerly housed a drycleaner. Canister samples of indoor air were collected in April and August of 2005, and the results were compared with shallow soil-gas and sub-slab soil-gas results. PCE concentrations in the five indoor air samples ranged from 3.7 to 16 ppbv, with four of five results between 10 and 16 ppbv.

For comparison, the ambient air contained 0.11 ppbv. The six samples of shallow soil gas collected at a depth of 5 feet (1.5 m) bgs directly within or near the building had from 39 to 780 ppbv of PCE. The highest of the three sub-slab soil-gas samples had 2,600,000 ppbv of PCE. The time-averaged indoor air concentration of 12 ppbv corresponds to a cancer risk of 2E-05 based on an inhalation unit risk of 3.0E-06 per ug/$m^3$ and an occupational exposure scenario of 8 hr/day, 5 day/week, 50 week/yr for 25 years.
http://www.epa.gov/ORD/NRMRL/pubs/540r07002/540r07002.htm

### Hand-Portable Mass Spectrometer Characterized for Analysis of Aqueous Trace Level Contaminants

Noll, R.J., A.D. Keil, and H. Hernandez (Purdue Univ., West Lafayette, IN); C. Janfelt (Copenhagen Univ., Denmark); R.G. Cooks (Purdue Univ.).
55th ASMS Conference on Mass Spectrometry, Indianapolis, IN, 3-7 June 2007

Portable instruments capable of quantifying explosives and solvents at part per billion (ppb) levels are desirable for performing in situ analysis. Membrane inlet mass spectrometry (MIMS) is an obvious choice for sample introduction; analytes preferentially partition from the sample into and through the membrane into the mass spectrometer's vacuum chamber. MIMS effectively selects against sample matrix, obviating the need for large vacuum pumps. Experiments were performed on a hand-portable miniature mass spectrometer equipped with MIMS inlet. Analytes at trace levels in aqueous solution were drawn (4.0 mL/min) through the permeation membrane inlet. Neutral analyte molecules pass through the membrane and are ionized by electron impact. The mass analyzer is a miniature rectilinear ion trap, a linear quadrupole ion trap with simplified electrode geometry. Mass analysis is conducted by mass selective instability scan with resonance ejection. The scan function includes ionization, cooling, multiplier warm-up, and mass analysis periods. Aqueous solutions containing the explosives-related compounds PNT or DNT were tested, as well as the polycyclic aromatic hydrocarbons (PAHs) naphthalene, acenapthene, anthracene, phenanthrene, and pyrene. Solutions containing biphenyl or 4,4'-dichlorobiphenyl (PCB 15) were also tested. The PNT mass spectrum contains major peaks at m/z 137 (M+), 121, 107, 91, 89, 77, and 65 (low mass cutoff = 60), in basic agreement with the NIST mass spectrum. The spectrum for DNT contains the molecular ion (M+) peak at m/z 182, in small abundance, with the base peak at the fragment ion m/z 165. Other prominent peaks include m/z 119, 107, and m/z 89. Spectra for the PAH compounds typically contain only the molecular ion peaks. The spectrum of PCB 15 shows ion peaks at M+ as well as fragments corresponding to the loss of one or both chlorine atoms. Calibration data were acquired for DNT and the first four PAH compounds. Under conditions of flow rate, EI emission current, and MIMS inlet, limits of detection (LOD) for the PAHs were typically 1-10 ppb, with linear ranges of 1 to 3 orders of magnitude. LOD for DNT was about 100 ppb; this loss in sensitivity is due to decreased affinity of DNT for the membrane material. Response was linear over at least 2 orders of magnitude. Effects of ionization time, flow rate, and other data acquisition parameters were investigated and are described.

Heavy Metal Contamination from Mining Sites in South Morocco: 1. Use of a Biotest to Assess Metal Toxicity of Tailings and Soils
Boularbah, A. (Univ. Cadi Ayyad, Marrakech, Morocco), C. Schwartz, G. Bitton, and J.L. Morel.
Chemosphere, Vol 63 No 5, p 802-810, May 2006

To investigate the heavy metal toxicity of tailings and soils collected from five metal mines, investigators used the MetPAD biotest Kit, which detects toxicity resulting from heavy metals in environmental samples. This biotest, which was initially developed to assess the toxicity of aquatic samples, was adapted to the heterogeneous physico-chemical conditions of anthropogenic soils. Contrasting industrial soils were collected from four abandoned mines and one still active mine. The toxicity test was run concurrently with chemical analyses on the aqueous extracts of tailings materials and soils to assess the potential availability of heavy metals. Soil pH was variable, ranging from very acidic (pH 2.6) to alkaline values (pH 8.0-8.8). The general trend observed was an increase in metal toxicity measured by the biotest with increasing available metal contents in tailings materials and soils; therefore, the MetPAD test can be used as a rapid and sensitive predictive tool to assess heavy metal availability in soils contaminated by mining activities.

Hybrid Chem/Bio Ultradense NanoDevice Sensors (HOUNDS)
Reed, Mark A., Yale Univ., New Haven, CT.
AFRL-SR-AR-TR-06-0248, 43 pp, May 2006

This report describes technical progress toward a highly sensitive and selective molecular electronic sensor system. The effort uses state-of-the-art approaches for analyte detection and sensor design. The sensor system consists of a functionalized semiconductor nanowire matrix with a combination of different receptors ranging from highly specific nucleic acid reporters to broadband simple chemical reporters. A gating scheme provides a unique advantage that selectively tunes portions of the array to specific reactions, which enhances sensitivity and selectivity. This approach challenges the limits of detectability with a semiconductor nanowire FET that could scale to single-molecule detection (and high density) and ultra-sensitive nucleotide switches with unique selectivity and sensitivity.
http://handle.dtic.mil/100.2/ADA452671

A Hydrologic/Geophysical Method for Characterizing Flow and Transport Processes within The Vadose Zone
Alumbaugh, D.L. (Univ. of Wisconsin-Madison); D. LaBrecque (MultiPhase Technologies, LLC); J. Brainard (Sandia National Lab); T.C. Yeh (Univ. of Arizona).
DOE/ER/15014, 33 pp, 2004

The primary purpose of this project was to employ two geophysical imaging techniques, electrical resistivity tomography and cross-borehole ground penetrating radar, to image a controlled infiltration of a saline tracer under unsaturated flow conditions. The geophysical techniques have been correlated to other more traditional hydrologic measurements including neutron moisture measurements and induction conductivity logs. Images that resulted during two successive infiltrations indicate the development of what appear to be preferential pathways through the finer grained materials, although the results could also be produced by cationic capture of free ions in clays. In addition, the site, as well as the developing solute plume, exhibits

electrical anisotropy, which is likely related to flow properties. The geologic significance of this phenomenon is still under investigation.
http://www.osti.gov/energycitations/servlets/purl/820952-bPdWwU/native/

Immunochromatography Using Colloidal Gold-Antibody Probe for the Detection of Atrazine in Water Samples
Shim, W.B., Z.Y. Yang, J.Y. Kim, J.G. Choi, J.H. Je, S.J. Kang, A.Y. Kolosova, S.A. Eremin, and D.H. Chung, Gyeongsang National Univ., Chinju, Gyeongnam, Korea.
Journal of Agriculture and Food Chemistry, Vol 54 No 26, p 9728-9734, 27 Dec 2006

A monoclonal antibody (MAb) specific to atrazine was produced from the cloned hybridoma cell (AT-1-M3) and used to develop a direct competitive enzyme-linked immunosorbent assay (DC-ELISA) and immunochromatography (ICG) strip test for atrazine in water samples. The visual detection limit for the ICG strip was 3 ng/mL. This test required only 10 min to get results and one step of sample to perform the assay. The results of water samples spiked with 5, 10, 20, and 50 ng/mL of atrazine by ICG strip were in good agreement with those obtained by DC-ELISA. The ICG strip was sufficiently sensitive and accurate to be useful for rapid screening of atrazine in various water samples.

Improvement of Oligonucleotide Probe Design Criteria for Functional Gene Microarrays in Environmental Applications
Liebich, J., C.W. Schadt, S.C. Chong, Z. He, S.K. Rhee, and J.-Z. Zhou.
Applied and Environmental Microbiology, Vol 72 No 2, p 1688-1691, Feb 2006

To optimize oligonucleotide probe design criteria, PCR products with different similarities to probes were hybridized to a functional gene microarray designed to detect homologous genes from different organisms. In contrast to more restrictive probe designs based on a single criterion, simultaneous consideration of the percent similarity (<90%), the length of identical sequence stretches (<20 bases), and the binding free energy (>35 kcal/mol) was found to be predictive of probe specificity.
http://aem.asm.org/cgi/reprint/72/2/1688.pdf

In Situ Measurement of Nitrate Concentration Using Time Domain Reflectometry
Krishnapillai, M. and R. Sri Ranjan.
Annual conference of the Canadian Society of Bioengineering, 16-20 July 2006, Edmonton, Alberta. Paper 06-158, 7 pp, 2006

This paper presents an in situ method to measure nitrate concentration in a laboratory flow experiment using time domain reflectometry (TDR) data. Three flow cells (replicates) packed with a silty loam soil were subjected to a constant hydraulic gradient inducing saturated water flow through the flow cells. A 500 mg/L $NO_3$-N strength potassium nitrate solution source was connected at the inflow end, and nitrate concentration changes with time were monitored along the length of the flow cells by soil solution sampling and lab analysis for $NO_3$-N concentration. At the time of sampling, TDR wave forms were recorded using the TDR mini-probes inserted at regular intervals along the length of the flow cells. The bulk soil electrical conductivity and the water content values extracted from the TDR wave forms were used to predict the nitrate concentrations at different locations. The nitrate concentration values predicted

from the TDR data correlated well with the nitrate concentrations obtained through soil solution sampling method, indicating the possibility of using TDR for monitoring nitrate movement in groundwater non-destructively.
http://www.bioeng.ca/Events/Edm2006/PDFs/CSBE06158.pdf

Industrial Hygiene Sampling Guide
U.S. Army Center For Health Promotion and Preventive Medicine, Technical Guide 141, 159 pp, Jan 2007

This technical guide provides information and guidance to industrial hygiene (IH) customers in using the services of the U.S. Army Center for Health Promotion and Preventive Medicine laboratories. This information covers IH air and bulk material sample collection and factors to consider before collecting samples.
http://chppm-www.apgea.army.mil/documents/TG/TECHGUID/Tg141.pdf

Influence of In-Well Convection on Well Sampling
Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery.
U.S. Geological Survey Scientific Investigations Report 2006-5247, 21 pp, 2006

The convective movement of water in wells has potential implications for passive, or no-purge, and low-flow sampling approaches. Transport of dissolved oxygen to the screened interval can adversely affect the ability of passive samplers to produce accurate concentrations of oxygen-sensitive solutes, such as iron. Other potential consequences include mixing the screened-interval water with casing water and potentially allowing volatilization loss at the water surface. A field test of diffusion samplers in a convecting well during the winter, however, showed good agreement of chlorinated solvent concentrations with pumped samples, indicating that there was no negative impact of the convection on the utility of the samplers to collect volatile organic compound concentrations in that well. In the cases of low-flow sampling, convective circulation can cause the pumped sample to be a mixture of casing water and aquifer water. This can substantially increase the equilibration time of oxygen as an indicator parameter and can give false indications of the redox state. Data from this investigation show that simple in-well devices can effectively mitigate convective transport of oxygen. The devices can range from inflatable packers to simple baffle systems.
http://pubs.usgs.gov/sir/2006/5247/

Integrated Nanoscale Nanowire Correlated Electronic Nanosensing Technology (INNOCENT)
Lieber, Charles M.
AFRL-SR-AR-TR-06-0328, NTIS: ADA451494, 27 pp, June 2006

Development of highly-integrated, ultra-sensitive real-time electronic sensor arrays for detection of chemical and biological threats has been carried out by exploiting the unique electronic properties and integration potential of nanowire electronic devices. Silicon nanowires have been developed and assembled into arrays of sensor elements that provide highly robust, specific, and ultra-sensitive species identification while dramatically reducing false positives. Sensor modalities developed in this project are based on nanowire field-effect transistors, where unique specificities of sensor elements for chemical and biological threats has been achieved through specific surface modification using designed chemical and biological receptors for

threats of interest. Experiments have demonstrated biothreat (viruses and toxins) detection at better than 1 picomolar sensitivity, detection of chemical (explosive) threats at better than 100 ppb sensitivity, and simultaneous multiplexed detection from 10 or more addressable nanowire sensing elements. Signal-processing algorithms that allow for discrimination of real-false signals in the presence of noise also have been developed.
http://handle.dtic.mil/100.2/ADA451494

Investigation of Ground-Water Contamination at Solid Waste Management Unit 12, Naval Weapons Station Charleston, North Charleston, South Carolina
Vroblesky, D.A., C.C. Casey, M.D. Petkewich, M.A. Lowery, K.J. Conlon, and L.G. Harrelson. U.S. Geological Survey. Scientific Investigations Report 2006-5311, 81 pp, June 2007

The U.S. Geological Survey and the Naval Facilities Engineering Command Southeast investigated natural and engineered remediation at Solid Waste Management Unit 12 at Naval Weapons Station Charleston, SC, of chlorinated organics groundwater contamination, primarily tetrachloroethene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride (VC), 1,1-dichloroethane (1,1-DCA), and 1,1-dichloroethene (1,1-DCE). The groundwater contamination extends eastward in the surficial aquifer from the probable source area near a former underground storage tank. Engineered remediation approaches include a permeable reactive barrier (PRB) and phytoremediation. The central part of the PRB along the main axis of the contaminant plume appears to be actively removing contamination; however, groundwater contamination is moving around the southern end of the PRB. Changes in the contaminant concentrations along the path of groundwater transport reflect a complex variety of influences. Potential influences include dechlorination, sorption and desorption, transpirative removal by trees, lateral shifting of the plume, and the presence of zones of differing concentrations possibly reflecting one or more pulse releases of contamination from the source area. Near the source area at well 12MW-10S, concentrations of cis-1,2-DCE, VC, 1,1-DCA, and 1,1,1-TCA continued an irregular decline, while PCE and 1,1-DCE showed marked fluctuations in concentration during 2005 and 2006. Volatile organic compound concentrations at well 12MW-03S continued to show decreasing concentrations, with the June 2006 concentrations being the lowest yet recorded at that well for several VOCs. Concentration and delta carbon 13 data indicate that in the upgradient part of the plume, PCE is being degraded to TCE, which is being degraded to cis-1,2-DCE, and cis-1,2-DCE is accumulating faster than it is being depleted. Groundwater VOC concentrations also changed in some wells in the forested area in the midpart of the plume. Increasing PCE and decreasing TCE and 1,1-DCE concentrations were observed at wells 12MW-05S and 12MW-29S, possibly reflecting a lateral shift in the axis of the contamination plume or an advancing contamination pulse. Substantial decreases in contamination occur in the forested area downgradient from well 12MW-05S. Probable major loss mechanisms in this area include evapotranspiration and sorption.
http://pubs.usgs.gov/sir/2006/5311/

Ion Imprinted Polymer Based Sensor for Monitoring Toxic Uranium in Environmental Samples
Metilda, P., K. Prasad, R. Kala, J.M. Gladis, T.P. Raoa, and G.R.K. Naidu.
Analytica Chimica Acta, Vol 582 No 1, p 147-153, 16 Jan 2007

Conventional ion selective electrodes such as those that are ionophore based, generally are not sufficiently sensitive or selective for ultratrace analysis. An ion imprinted polymer (biomimetic) based potentiometric sensor has been developed for ultratrace uranyl analysis. The sensor is made by dispersing uranyl ion imprinted polymer particles in plasticizer (2-nitrophenyloctyl ether) and embedding it in a polyvinyl chloride matrix. The sensor responds to uranyl ion over a wide concentration range, with a detection limit of $2.0\times10^{-8}$ M. It showed good selectivity over alkali, alkaline earth, transition and heavy metal cations. The sensor was successfully tested in tap and sea water samples.
http://www.aseanenvironment.info/Abstract/41014412.pdf

Lab-on-a-Chip Device from Berkeley Lab to Speed Proteomics Research
Lawrence Berkeley National Laboratory News Release, 2 May 2007

Genomics is the study of genes and their functions. The genomics era is now making way for the era of proteomics─the study of the proteins that genes encode. Future proteomics research should see a substantial acceleration with the development of a new device that provides the first monolithic interface between mass spectrometry and silicon/silica-based microfluidic lab-on-a-chip technologies. The multinozzle nanoelectrospray emitter array was developed by scientists with DOE's Lawrence Berkeley National Laboratory. Lab-on-a-chip technology has enormous potential for proteomics research, but for the potential to be fully realized, a major advance in interfacing microfluidics with mass spectrometry has been needed. The new device provides that interface. One of the first steps in proteomics research is to determine the identity and modifications of individual proteins that make up a cell or tissue sample. The principal means of doing this is through mass spectrometry. Mass spectrometers use a combination of ionization and magnets to separate a protein's constituent peptides. Detection and analysis of this mass spectrum can then be used to identify the protein and quantify its presence in a sample. The most popular technique today for ionizing a protein's constituents for mass spectrometry is to liquefy the protein and send it through electrically charged capillaries--a technique known as electrospray ionization. One of the best candidates for high throughput integration of the detection and analysis processes is to interface the mass spectrometers with lab-on-a-chip technology, where biological fluids are introduced onto a microprocessor chip. Until how, microfluidic analysis of proteins has been a separate process from mass spectrometry. The fabrication and application of microfabricated monolithic multinozzle emitters, called "M3 emitters" for short, could be commercialized immediately and should be highly competitive with current silica capillary emitters in terms of cost and mass production. The researchers are now in the process of creating a chip that integrates sample processing and preparation as well as detection and analysis. Berkeley lab has filed for a patent on this technology.
http://www.lbl.gov/Science-Articles/Archive/MSD-lab-chip.html

Laboratory and In Situ Evaluation of Enzyme Activity-Dependent Fluorescent Probes Specific for Chlorinated Solvent Degrading Bacteria
Watwood, M.E., Idaho State Univ., Pocatello.
NTIS: DE2007-895979, 7 pp, Apr 2006

Several bacterial groups commonly found in soil and ground water are capable of oxidative, cometabolic degradation of trichloroethene (TCE). This research effort has developed enzyme activity-dependent probes for most of the toluene oxygenase pathways that cometabolize TCE. In conjunction with Frank Roberto and Amber Miller of Idaho National Engineering and Environmental Laboratory (INEEL), an enzyme activity-dependent probe for soluble methane monooxygenase has been developed that also cometabolizes TCE. These probes are surrogate substrates that are transformed by the enzyme to yield fluorescent and/or colored products. They give a clear, quantifiable signal only when the enzyme of interest is actively functioning. Their pathway specificities have been demonstrated, and response of the probes has been correlated with TCE degradation in microcosm studies. PCR primer sets specific for the genes encoding the initial hydrolase for each of the toluene oxidizing pathways have also been developed. The primers were located within the open reading frame of the gene so that they could be used with extracted DNA to detect the presence of the gene and with extracted mRNA to detect active transcription. Additional approaches to analyzing bacteria containing the toluene oxygenase pathways include fluorescent in situ hybridization (FISH) and 5-cyano,2,3-ditotyl tetrazolium chloride (CTC) reduction. FISH of whole cells using 16s rRNA oligonucleotide probes is a powerful technique for evaluating the identity, abundance, and relative activity of microbial cells. CTC is a monotetrazolium redox dye that produces a fluorescent formazan crystal when biologically or chemically reduced. CTC provides a direct visualization of actively respiring bacterial cells. These techniques allow examination of relationships between microbial community metabolic activity, single-cell metabolic activity, and specific enzyme activity in laboratory test cultures. The status of microbes containing the desired degradative enzymes has been assessed by applying the entire suite of these techniques. The techniques were applied to ground-water samples from the TCE-contaminated aquifer at the Test Area North (TAN) site at INEEL. Cells were harvested from the samples by sterile filtration of the ground water. The results from two full field trials of the enzyme activity probes at the TAN site, along with molecular analysis and other approaches, indicate substantial levels of toluene oxygenase and soluble methane monooxygenase activity. This type of information can play a pivotal role in verification of monitored natural attenuation, as well as active bioremediation monitoring.

Mathematical Analysis of the Whole Core Injection Method Accuracy for Measuring Phenanthrene Biodegradation Rates in Undisturbed Marine Sediments
Tang, Y.J. and B. Krieger-Brockett.
Chemosphere, Vol 68 No 5, p 804-813, June 2007

A whole core injection method was used to measure rates of 14C-phenanthrene mineralization in contaminated, undisturbed marine sediments. The purpose of the measurements was to assess microbial natural attenuation activity as a function of sediment depth. Submerged sediment samples from the Eagle Harbor Superfund site showed significant 14C-phenanthrene biodegradation activities (0.0012 to 0.0036 per day) in the upper 10 cm horizon. This paper evaluates the results of the experiment and presents a mathematical simulation that describes competing contaminant diffusion and simultaneous biodegradation (Monod kinetics), both retarded by sorption. The simulation predictions provide quantitative guidelines that are given in the paper for the successful use of the whole core injection method.

Mathematical Simulation and Long-Term Monitoring of Leachate Components from Two Different Landfill Cells

Ozkaya, B. (Yildiz Technical University, Besiktas, Istanbul, Turkey); A. Demir; and M.S. Bilgili.

Journal of Hazardous Materials, Vol 135 Nos 1-3, p 32-39, 31 July 2006

The leachate produced in two large-scale test cells at the Odayeri Sanitary Landfill, Istanbul, Turkey was monitored for 920 days. Parameters of interest were sulfate ($SO_4^{2-}$), chloride ($Cl^-$), chemical oxygen demand (COD) and biological oxygen demand (BOD). One of the test cells was used as a control and the other employed a leachate recirculation system. The relationship between the parameters and refuse age was modeled. A good fit was obtained between the measured data and model simulations. After one month of landfilling, the COD concentrations reached their maximum values of 75 g/L in the control cell and 70 g/L, in the recirculation cell. During the acidogenic phase of development, BOD to COD ratios were about 0.8 for both test cells. After some time, however, this ratio decreased to 0.06. At about two months of operation there was a sharp decrease in the concentration of $Cl^-$ of about 14 to 15 g/L. Within 45 days of operation, $SO_4^{2-}$ concentrations reached a maximum value of 2000 mg/L. After 5 months of operation, sulfate reducing bacteria, under anaerobic conditions, caused a sharp drop in concentrations to around 75 mg/L for the recirculation cell and 450 mg/l for the control cell. The results indicated that there was little difference in leachate quality between the two cells in terms of COD and BOD values.

http://www.aseanenvironment.info/Abstract/41013240.pdf

A Mechanism Study of Reflectance Spectroscopy for Investigating Heavy Metals in Soils

Wu, Yunzhao (State Key Lab. of Remote Sensing Science, China); Jun Chen; Junfeng Ji; Peng Gong; Qilin Liao; Qingjiu Tian; and Hongrui Ma.

Soil Science Society of America Journal, Vol 71, p 918-926, 2007

The authors explored the physicochemical mechanism and the potential of reflectance spectroscopy as an alternative method for assessing heavy metals in soil. An examination of the spectral response of changing concentrations of heavy metals in soils indicated that only at very high concentration can transition elements exhibit their inherent absorption features. Nonetheless, the researchers successfully predicted low levels of heavy metals in agricultural soils, with the best prediction accuracies obtained for Ni, Cr, and Co and the poorest prediction for Cd. The order of prediction accuracy for metals was approximately the same as the order of their correlation coefficients with Fe, and the study results indicate that the correlation with total Fe (including active and residual Fe) is the major mechanism.

A Method to Measure Arsenic Readily Released to Pore Waters from Uranium Mill Tailings
Mahoney, J. (Hydrologic Consultants, Inc., Lakewood, CO); D. Langmuir (Hydrochem Systems Corp., Denver, CO); John Rowson (COGEMA Resources, Inc., Saskatoon, SK, Canada).
Uranium in the Environment: Mining Impact and Consequences. Springer, ISBN: 978-3-540-28363-8, p 97-106, 2006

A method to quantify the amount of readily released arsenic in uranium mill tailings was developed using a technique known as equilibrium partitioning in closed systems (EPICS). The method employs a gentle leaching solution that, except for its arsenic (As) concentration, is identical to the neutralized raffinate that contacts the tailings. Prior to implementation, the experimental design and mathematical approach were verified in geochemical models using PHREEQC. Laboratory experiments using field tailings showed that As that could be readily released to pore waters comprised about 0.2% of the total As in the tailings.

Methods For Sediment Sampling and Analysis
United Nations Environment Programme, UNEP(DEC)/MED WG.282/Inf.5/Rev.1, 25 pp, Mar 2006

The sediment sampling strategy set prior to monitoring activity is critically important and should be established with caution to ensure that it is appropriate to the sampling site conditions and to achieve the statistical objectives of a trend-monitoring program. To facilitate the work of those in charge of the monitoring program, two different approaches—the minimum requirement and the state of the art—are indicated for sampling, sieving, and analyzing the samples so that investigators can use the approach that best corresponds to the monitoring purpose and budget. This manual, which was drafted by Dr. Jean-Pierre Villeneuve (IAEA/MESL), takes into account the recommendations of an expert meeting on sampling strategy and analysis for sediments in coastal waters. The manual also contains a detailed section on sampling instruments and sample handling.
http://www.sednet.org/component/option,com_remository/Itemid,83/func,fileinfo/id,100/

Microarray-Based Analysis of Subnanogram Quantities of Microbial Community DNAs by Using Wholecommunity Genome Amplification
Wu, L., X. Liu, C.W. Schadt, and J.-Z. Zhou.
Applied and Environmental Microbiology, Vol 72 No 7, p 4931-4941, July 2006

Microarray technology can identify thousands of microbial genes or populations simultaneously if the microbial biomass is sufficiently high. To address insufficient biomass issues, an approach using whole-community genome amplification-assisted microarray detection based on multiple displacement amplification was developed. Several microarrays and quantitative indexes were used to evaluate the representativeness of the amplification. Representative detection of individual genes or genomes was obtained with 1 to 500 ng community DNAs from groundwater. There were significant linear relationships observed between signal intensities and initial DNA concentrations that ranged from 0.04 to 125 ng ($r^2$ = 0.65 to 0.99) for DNA from pure cultures as detected by whole-genome open reading frame arrays, to 0.01 to 250 ng ($r^2$ = 0.96 to 0.98) for community DNAs from ethanol-amended groundwater using 50-mer functional gene arrays. Using the microarray technology microbial communities in groundwater contaminated with uranium and other metals was investigated. While microorganisms containing genes involved in contaminant degradation and

immobilization were present, microbial diversity was shown to be greatly reduced in the highly contaminated environment.
http://aem.asm.org/cgi/content/full/72/7/4931?ck=nck

Microchip Device for Rapid Screening and Fingerprint Identification of Phenolic Pollutants
Wang, J., W. Siangproh, A.J. Blasco, O. Chailapakul, and A. Escarpa.
Analytica Chimica Acta, Vol 556 No 2, p 301-305, 25 Jan 2006

A microchip protocol measuring total phenols as well as speciation of them was developed. The protocol uses a microchip flow-injection analysis for screening for total phenols. After phenols are detected it can be switched to a separation mode by exchanging the run buffers in the separation channel. The screening mode employs an acidic run buffer (pH 5) while the separation mode uses a basic buffer (pH 8). The base leads to ionization of the phenolic compounds and to their effective separation and detection. The method is capable of screening about 120 samples per hour. About 18 samples per hour can be speciated. The paper describes the process in depth.
http://www.aseanenvironment.info/Abstract/43004644.pdf

Microwave-Assisted Extraction of Pyrethroid Insecticides from Semi Permeable Membrane Devices (SPMDs) Used to Indoor Air Monitoring
Esteve-Turrillas, F.A., A. Pastor (University of Valencia, Valencia, Spain), and M. de la Guardia.
Analytica Chimica Acta, Vol 522 No 1, p 73-78, 20 Sep 2004

The gaseous phase pyrethroids Allethrin, Prallethrin, Tetramethrin, Bifenthrin, Phenothrin, λ-Cyhalothrin, Permethrin, Cyfluthrin, Cypermethrin, Flucythrinate, Esfenvalerate, Fluvalinate and Deltamethrin were preconcentrated in a semi permeable membrane device (SPMD). Their analysis was accomplished by gas chromatography mass–mass spectrometry determination after a microwave-assisted extraction, in front of the dialysis method. A 30mL hexane:acetone solution was used for two extractions of the SPMDs. Clean-up of the extracts was performed by acetonitrile–hexane partitioning and solid-phase extraction. Detection limits ranged from 0.3 to 0.9 ng/SPMD with a relative standard deviation, from 2.9 to 9.4%. Matrix spike recoveries were from 61±8 to 103±7% for microwave assisted extraction, versus 54±4 to 104±3% for the dialysis reference method. Analysis time using the new procedure was reduced from 48 hours to one. High concentrations of pyrethroid compounds were found in indoor air after 2 hours of a standard application.
http://www.aseanenvironment.info/Abstract/41012665.pdf

Mineralogical Preservation of Solid Samples Collected from Anoxic Subsurface Environments
Wilkin, Richard T., U.S. EPA, Ada, OK.
EPA 600-R-06-112, 8 pp, Oct 2006

This issue paper discusses mineralogical preservation methods for solid samples that can be applied during site characterization studies and assessments of remedial performance. A preservation protocol is presented that is applicable to solids collected from anoxic subsurface environments, such as soils, aquifers, and sediments. The preservation method evaluated and recommended here for solids collected from anoxic environments involves sample freezing (-18

degrees C), transportation of frozen samples on dry ice, and laboratory processing of solids in an anaerobic glove box. This method was found to preserve the redox integrity of reduced iron- and sulfur-bearing compounds, which are typically predominant redox-sensitive inorganic constituents in environmental materials and are important in controlling contaminant behavior at hazardous waste sites.
http://www.epa.gov/ada/pubs/issue.html

Measuring the Flux at the Interface of Coal-Tar Impacted Sediment and River Water Near a Former MGP Site
Hun, S., C.T. Jafvert, B. Jenkinson, C. Enfield, and B. Johnson.
Chemosphere, Vol 68 No 6, p 1020-1029, June 2007

Field studies were conducted at a former manufactured gas plant site to measure the water flow and contaminant flux across the groundwater/surface water interface into an adjacent river. To facilitate the measurements, an interfacial flow meter was developed and tested. The flux system consisted of a cylinder with a domed head. A flow tube attached to the head allows water to flow from the device to the river at the rate equal to the specific discharge across the sediment-surface water boundary. Flow rate was measured by heating water in the tube and measuring its travel progress over time. The instrument was then used to calculate the mass flux of several PAHs (polycyclic aromatic hydrocarbons) that are derived from the coal tar impacted sediments. Mass flux information at the sediment-water interface is useful for site assessment and evaluation of remediation alternatives.

Multi-functional Nanowire Evanescent Wave Optical Sensors
Sirbuly, D.J., A. Tao, M. Law, R. Fan, and P. Yang.
Advanced Materials, Vol 99 No 1, 2006

This article presents a description of an optical sensing platform that utilizes the evanescent field of a tin dioxide single crystalline waveguide to perform a wide array of spectroscopic analyses. These analyses include surface enhanced Raman on sub-picoliter probe volumes, absorption, and fluorescence. Multiple modes of detection can be carried out on the same analyte because the same waveguide cavity can transmit both broadband and monochromatic light. The platform can use an amplified electric field around silver nanocubes to enhance the vibronic signatures of molecules present in the evanescent field. The waveguides can be completely cleaned from the attached metal nanoparticles making the devices fully reusable.

A Multi-Residue Method for the Analysis of Insecticides Collected on Cotton Surface Wipes
Clifton, M. and D.M. Stout, U.S. EPA.
55th ASMS Conference on Mass Spectrometry, Indianapolis, IN, 3-7 June 2007

A method was developed for the extraction, cleanup, and analysis of multiple pesticides from cotton wipe media used in human exposure studies to collect residues from residential hard surfaces. Methods used previously for multi-residue analysis of cotton wipes have been difficult to use for routine analysis at trace levels due to extensive problems with matrix effects from the cotton media and the hard surfaces being sampled. This method incorporates a multi-stage SPE clean-up procedure to remove extraneous compounds. An effective approach to correct for extraction efficiency and matrix effects based primarily on response enhancement on the GC/MS system is described.

Nano-Scale Secondary Ion Mass Spectrometry: A New Analytical Tool in Biogeochemistry and Soil Ecology
Herrmann, A.M., K. Ritz, N. Nunan, P.L. Clode, J. Pett-Ridge, M.R. Kilburn, D.V. Murphy, A.G. O'Donnell, and E.A. Stockdale.
Soil Biology and Biochemistry, Vol 39, p 1835-1850, 17 Apr 2007 [UCRL-JRNL-225506]

A new approach to biogeochemistry and soil ecology using nano-scale secondary ion mass spectrometer (NanoSIMS) is discussed. NanoSIMS is the latest generation of ion microprobes that can link high-resolution microscopy with isotopic analysis. Its high mass resolution and maintenance of signal transmission and spatial resolution (~50 nm) give it an advantage over other secondary ion mass spectrometers. This paper describes the principles of NanoSIMS and discusses its potential to contribute to the field of biogeochemistry and soil ecology. Practical considerations that include sample size and preparation, simultaneous collection of isotopes, and mass resolution are reviewed.
http://www.llnl.gov/tid/lof/documents/pdf/339974.pdf

Nanotubes, Nanowires, and Nanocantilevers in Biosensor Development
Wang, Jun, Guodong Liu, and Yuehe Lin.
Nanomaterials for Biosensors, Nanotechnologies for Life Sciences, Vol 8, p 56-100, 2007

In this chapter, the reviewers introduce biosensor development based on 1-D nanomaterials, carbon nanotubes (CNTs), semiconducting nanowires, and some cantilevers. The main emphasis is placed on CNTs and electrochemical/electronic biosensor developments. Section 2 gives a detailed description of CNT-based biosensor development, including the fabrication of CNTs, the strategies for construction of CNT-based biosensors, and their bioapplications. The applications of CNT-based-biosensors and various detection principles (e.g., electrochemical, electronic, and optical methods) are reviewed in detail. Section 3 introduces the method for synthesizing semiconducting nanowires (e.g., silicon nanowires, conducting polymer nanowires, and metal oxide nanowires) and their applications in DNA and proteins sensing. Section 4 describes the development of nanocantilever-based biosensors and their application in DNA and protein diagnosis. [PNNL-SA-53317]

Natural Attenuation Assessment Using Mineral Data
Everett, J.W.; L.G. Kennedy; J. Gonzales, Rowan Univ., Glassboro, NJ.
Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol 10 No 4 , p 256-263, Oct 2006

This paper discusses aqueous and mineral intrinsic biodegradation assessment (AMIBA) techniques. AMIBA concerns the measurement and interpretation of the presence of iron and sulfur mineral species in subsurface soils to evaluate the intrinsic bioremediation component of natural attenuation. The paper focuses on sample collection and data interpretation. Experimental results from three sites are also discussed. These site results illustrate different conditions and outcomes. Multiple soil borings were made and sampled at multiple depths at each site. The soil samples, as well as groundwater samples, were analyzed for contaminants of concern, Fe(II) and

Fe(III) minerals, iron sulfide (as FeS and $FeS_2$) minerals, nitrate, oxygen, and sulfate. AMIBA was successfully used to estimate contaminant destruction and depletion rates. Iron and sulfate were consistently dominant electron acceptors except at one site where nitrate was present due to human activities.

Natural Gradient Tracer Test for a Permeable Reactive Barrier in Denmark. I: Field Study of Tracer Movement
Lai, K.C.K.; I.M.C. Lo (Hong Kong Univ. of Science and Technology, Clear Water Bay, Kowloon, Hong Kong); and P. Kjeldsen.
Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol 10 No 4, p 231-244, 2006

A funnel-and-gate permeable reactive barrier (PRB) packed with zero-valent iron (ZVI) was installed in 1999 at the Vapokon site in Denmark for groundwater remediation. To understand the behavior of groundwater flow through the PRB, a natural gradient tracer experiment was conducted to provide detailed information describing the transport of a nonreactive tracer (lithium ion, Li+) across the PRB. The movement of the Li+ plume monitored from a dense network of multilevel samplers indicated that the contaminated groundwater passed through the PRB rather than bypassing it; however, a noticeable lateral change of the flow path and downward movement of the Li+ plume was observed in the immediate vicinity of the front edge of the ZVI reactive medium, probably due to the sectional clogging of the ZVI caused by mineral precipitates. Afterward, the Li+ plume flowed preferentially along the PRB. Gravel packs installed just upgradient and downgradient of the barrier had a minor effect on enhancing mixing of the Li+ plume, thereby indicating its limited effect on the attenuation of the difference in the large spatial concentration within a contaminant plume.

Natural Gradient Tracer Test for a Permeable Reactive Barrier in Denmark. II: Spatial Moments Analysis and Dispersion of Conservative Tracer
Lai, K.C.K.; I.M.C. Lo (Hong Kong Univ. of Science and Technology, Clear Water Bay, Kowloon, Hong Kong); and P. Kjeldsen.
Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol 10 No 4, p 245-255, 2006

A natural gradient tracer experiment was conducted for a permeable reactive barrier (PRB) installed at the Vapokon site in Denmark to estimate the groundwater velocity inside the zero-valent iron (ZVI) reactive medium and to determine also the longitudinal dispersivity (alpha(y)). First-moment analysis of the tracer (lithium ion, Li+) plume gave a groundwater velocity of 99.5m/ yr within the ZVI reactive medium, and an average alpha(y) of 0.275m was determined for the ZVI using a 1-D advection-dispersion equation. A comparison of the chlorinated aliphatic hydrocarbon (CAH) concentration profiles in a ZVI-packed barrier, with and without dispersion effects, showed a notable increase in the CAH concentration with alpha(y). The conventional application of a first-order equation, or an assumption of insignificant dispersion of contaminants during designing the ZVI thickness in a full-scale PRB, can overestimate its groundwater remediation efficiency. As a result, a dispersion correction factor ranging from 1.2 to 4.2 was determined for the predicted ZVI thickness based upon the groundwater velocity of 99.5m/yr, as well as the dechlorination rate constant of 0.05 and 0.3/h.

A New Device and Method for Measuring Volatile Compounds in Monitoring Wells
Cantrell, K., T. Gilmore, W. Hyde, K. Vangelas, and B. Looney.
WSRC-STI-2006-00293, 20 pp, Nov 2006

The ability to measure dissolved volatile compounds quickly in the field is important to facilitate timely characterization decisions and to optimize remediation systems. A device was designed and tested that is easy to use, provides accurate and reproducible data, minimizes waste generation, and provides results immediately after measurement. The device is designed to convert dissolved volatile compounds to the vapor phase for measurement using commercially available gas analyzers. The measured concentration of volatile compounds in the vapor phase is used to calculate the equilibrium concentration in the dissolved phase using Henry's Law. The device was tested in the laboratory and field using trichloroethene (TCE). Laboratory tests were conducted over a concentration range of 11 to 7,000 ppb TCE in water. The results indicate that equilibrium is reached in less than one minute. At the high end of this concentration range, results were within 10% of those measured by a standard laboratory GC method. The low end the system was biased high but still within a factor of 2 of the GC result. The device also can measure a wide variety of other volatile compounds. In-well measurements with the device in combination with a photoacoustic gas monitor could be made within about 5 minutes and within 7% of measurements made using standard laboratory gas chromatography methods for samples above 20 ppb; however, results below about 20 ppb were systematically higher than the standard laboratory GC method. The logistics and costs of the sampling device are somewhat complex, and additional work will be required to develop this technique for in-field use.
http://sti.srs.gov/fulltext/WSRC-STI-2006-00293.pdf

Novel Valve for Automatic Calibration of a Chloride Sensor for River Monitoring
Hahn, Federico, VIKSAL, Zihuatanejo, Guerrero, Mexico.
Biosystems Engineering, Vol 92 No 3, p 275-284, Nov 2005

Remote-sensing water monitoring for detecting pollution points requires automatic calibration of chloride-ion-sensitive electrodes, as their calibration is lost after 2 h. A valve was designed using two stepper motors that, depending on the motors' position, allows calibration reference liquid injection, as well as distilled water and sampling water to flow toward the sensor cavity. The stepper motor routines for sensor cleaning, sensor calibration, and water monitoring are explained in this paper. Sensor cavity leveling to $0^o$ was essential for proper operation, and the valve can work properly with any sensor using two-point calibration. The automatic device measured continuously for 7 days when the valve was positioned outside the water. Continuous measurements were taken in an effluent of the River Texcoco near Mexico City.
http://www.aseanenvironment.info/Abstract/41012189.pdf

An Online Real-Time Biomonitor for Contaminant Surveillance in Water Supplies
Mikol, Y.B., W.R. Richardson, W,H. van der Schalie, T.R. Shedd, and M.W. Widder; NYC Dept. of Environmental Protection, Flushing.
Journal AWWA, Vol 99 No 2, p 107-116, Feb 2007 [NTIS: ADA462742]

Automated biomonitoring systems provide continuous, real-time monitoring of changes in water quality and can rapidly identify toxicity associated with a wide range of chemical contaminants while increasing public confidence in drinking water quality. Biomonitor use is widespread in Europe but rare in the United States. This paper illustrates how biomonitors can

contribute to an early warning monitoring system for source and finished water protection using case studies of a biomonitor that continuously monitors the fish ventilatory patterns integrated with basic water quality parameters. At two water utilities, the biomonitor was operational ~96% of the time. Toxicity alarms occurred for a small diesel oil spill and a probable agricultural chemical release. The case studies provide a context for a discussion of considerations important for biomonitor implementation, including toxicant responsiveness, event confirmation, biomonitor implementation in a decision-making process, and costs. Recommendations are provided for biomonitor use at raw-water intakes and in distribution systems.
http://handle.dtic.mil/100.2/ADA462742

Optical Fiber Chemical Sensor with Sol-Gel Derived Refractive Material as Transducer for High Temperature Gas Sensing in Clean Coal Technology
Tao, Shiquan, Mississippi State Univ., Starksville.
U.S. DOE Contract FC26-04NT42230, 96 pp, 2007

Three classes of fiber optic sensors have been developed based on the thorough investigation of sol-gel chemistry and sol-gel derived materials. The first group of fiber optic sensors uses porous silica optical fibers doped with metal ions or metal oxide as transducers for sensing trace $NH_3$ and $H_2S$ in high temperature gas samples. The second group of fiber optic sensors uses sol-gel derived porous silica materials doped with nanometer particles of noble metals in the form of fiber or coating for sensing trace $H_2$, $NH_3$, and HCl in gas samples for ambient temperature applications. The third class of fiber optic sensors uses sol-gel derived semiconductor metal oxide coating on the surface of silica optical fiber as a transducer for selectively sensing $H_2$, $CH_4$, and CO at high temperature. In addition, optical fiber temperature sensors use the fluorescence signal of rare-earth metal ions-doped porous silica optical fiber. The optical absorption signal of thermochromic metal oxide materials coated on the surface of silica optical fibers has also been developed for monitoring the gas temperature of corrosive gas. Based on the results obtained from this project, the principle of fiber optic sensor techniques for monitoring matrix gas components as well as trace components of coal gasification-derived syngas has been established. Prototype sensors for sensing trace ammonia and hydrogen sulfide in gasification-derived syngas have been built in the laboratory and tested using gas samples with matrix gas composition similar to that of gasification-derived fuel gas. Test results illustrate the feasibility of these sensors for applications in integrated gasification combined cycle (IGCC) processes in coal-fired power plants.
http://www.osti.gov/energycitations/servlets/purl/901089-nsJ1SU/

Optical Organophosphate Sensor Based Upon Gold Nanoparticle Functionalized Fumed Silica Gel
Newman, J.D., J.M. Roberts, and G.J. Blanchard, Michigan State Univ., East Lansing.
Analytical Chemistry, Vol 79 No 9, p 3448-3454, 2007

A high-surface-area, chemically selective material has been created for the efficient adsorption of organophosphate (OPP) and organophosphonate species using silica microparticles in conjunction with gold nanoparticles and surface modification chemistry. The binding of OPPs to the modified gold nanoparticles appears as a spectral shift in the gold nanoparticle resonance. The sensitivity of this technique is limited by scattering losses of suspensions of the particles;

however, this sensitivity can be recovered to a significant extent by the use of solvents with a refractive index close to that of the silica particles.

Optical Remote Sensing for Air Quality Monitoring
Varma, R.M., R.A. Hashmonay, R.H. Kagann, M.T. Modrak, & M.A. Bolch (ARCADIS); D.B. Harris (U.S. EPA); B.J. Kim (U.S. Army Engineer Research and Development Center, CERL).
BAQ 2004: Conference on Better Air Quality, Agra, India, 6-8 December 2004

This paper outlines developments in using optical remote sensing (ORS) instruments for air quality monitoring both for gaseous pollutants and airborne particulate matter (PM). The U.S. EPA) has been using open-path Fourier transform infrared spectrometers (OP-FTIR), open-path tunable diode lasers (TDL) and ultraviolet differential absorption spectroscopy (UV-DOAS) for monitoring pollutant gases from various sources. The use of a scanning ORS instrument and recently developed radial plume mapping (RPM) configurations allow for near real-time flux estimation and source characterization for fugitive and area emissions. Open-path measurement projects performed by EPA and ARCADIS have characterized emissions from landfills, urban ambient air, vehicular exhausts, and industrial fence-line monitoring for various toxic pollutants. In addition to gaseous pollutants, airborne PM from various human and natural activities can also have a negative impact on ambient air quality, and this paper outlines developments in utilizing ORS instruments for PM monitoring. The extinction of light over a broad range of wavelengths from OP-FTIR and UV-DOAS spectrometers can be used to identify and characterize airborne PM. OP-FTIR absorbance spectra acquired during changing aerosol conditions reveal related changes in very broad baseline features specific to particular PM sources. Although undesirable for gas species quantification, these features can be used in conjunction with Mie theory of light scattering to retrieve PM size distribution. The success of ORS instrument applications indicates that the approaches discussed in this paper show significant promise for air quality monitoring and regulatory applications in India and other parts of Asia as well.
http://www.cleanairnet.org/baq2004/1527/articles-59245_varma.doc

Passive Air Sampler as a Tool for Long-Term Air Pollution Monitoring: Part 1. Air Genotoxic Potency Screening Assessment
Cupr, P., J. Klanova, T. Bartos, Z. Flegrova, J. Kohoutek, and I. Holoubek, Masaryk Univ., Brno, Czech Republic.

Environmental Pollution, Vol 144 No 2, p 393-405, Nov 2006 periods. The study was successful in providing information on the fate and transport of plant emissions. Passive samplers can be used to evaluate temporal and spatial fluctuation in concentrations of persistent organic pollutants in the ambient air, which makes them applicable for monitoring on the local scale.
http://www.aseanenvironment.info/Abstract/41013942.pdf

Passive Air Sampler as a Tool for Long-Term Air Pollution Monitoring: Part 2. Air Genotoxic Potency Screening Assessment
Cupr, P. J. Klanova, T. Bartos, Z. Flegrova, J. Kohoutek, and I. Holoubek, Masaryk Univ., Brno, Czech Republic.
Environmental Pollution, Vol 144 No 2, p 401-413, Nov 2006

The capability of passive air sampling to be employed in the evaluation of direct genotoxicity of ambient air samples was assessed. Genotoxic effects of the total extracts from the polyurethane foam filters exposed for 28 days during a regional passive air sampling campaign were investigated. Statistical analysis showed significant correlation between observed biological effects and PAHs concentrations in samples. Results of the study indicate not only a very good capability of the passive air samplers to reflect the spatial fluctuation in concentrations of persistent organic pollutants in the ambient air but also the feasibility of using this method for direct genotoxic potential assessment. The integration of the passive air sampling technique with the genotoxicological analysis may provide an effective tool for the air monitoring on various scales and for the screening of the genotoxic potential of ambient air samples. Geographical information system analysis facilitated the spatial results interpretation of this combination of the chemical analysis with the genotoxicity assay and provided an attractive tool for displaying the levels of air contamination and their genotoxic risks.
http://www.aseanenvironment.info/Abstract/41013943.pdf

Passive Flux Sampler for Measuring Nitrous Oxide and Methane Emissions from Agricultural Sources
Gaudet, E., S. Godbout, A. Marquis, R. Sneath, R. Phillips, and S. Lemay.
The CSAE/SCGR 2005 Meeting, Winnipeg, Manitoba, 26-29 June 2005. The Canadian Society for Engineering in Agricultural, Food, and Biological Systems. Paper 05-072, 20 pp, 2005

A new passive flux sampler capable of sampling both methane and nitrous oxide simultaneously has been developed. The new sampler—175 mm long and ~50 mm wide—is constructed entirely of stainless steel. It contains a zeolite, which is capable of adsorbing both methane and nitrous oxide. In a series of tests the adsorbent was found to be 91% +/- 11% efficient at adsorbing nitrous oxide and 9% +/- 6% efficient at adsorbing methane. Due to the low level of adsorption for methane, further testing was done for nitrous oxide only. In another series of tests, the overall sampler efficiency was found to be 99% +/- 17% efficient in wind speeds up to 5 m/s, decreasing with faster winds. This sampler is a cheap and effective method of sampling nitrous oxide emissions in air velocities up to 5 m/s.
http://www.bioeng.ca/Papers/2005/CSAE%20papers/05-072.pdf

Phase II Fort Ord Landfill Demonstration Task 8: Refinement of In-line Instrumental Analytical Tools to Evaluate their Operational Utility and Regulatory Acceptance
Daley, P.F.
UCRL-SR-220374, 69 pp, April 2006

The overall objective of this project is the continued development, installation, and testing of continuous water sampling and analysis technologies for application to on-site monitoring of groundwater treatment systems and remediation sites. In a previous project, an on-line analytical system (OLAS) for multistream water sampling was installed at the Fort Ord Operable Unit 2 Groundwater Treatment System, with the objective of developing a simplified

analytical method for detection of contaminants at that plant, and continuous sampling of up to 12 locations in the treatment system, from raw influent waters to treated effluent. The initial goals of integrating the preexisting LabVIEW (National Instruments, Inc., Austin, TX) chromatography control system with the ASAP (Analytical Sampling and Analysis Platform, A+RT, Milpitas, CA) and demonstrating a simplified, site-specific analytical method were successfully achieved, though several obstacles remained. Data reduction with the base LabVIEW system was limited to peak detection and simple tabular output, patterned after commercial chromatography integrators, with compound retention times and peak areas. Preparation of calibration curves, method detection limit estimates and trend plotting were performed with spreadsheets and statistics software. Moreover, the analytical method developed was very limited in compound coverage, and unable to closely mirror the standard analytical methods promulgated by the EPA. To address these deficiencies, the original equipment was operated at the OU 2-GTS to further evaluate the use of columns, commercial standard blends, and other components to broaden the compound coverage of the chromatography system. A second-generation ASAP was designed and built to replace the original system at the OU 2-GTS and to include provision for introduction of internal standard compounds and surrogates into each sample analyzed. An enhanced, LabVIEW-based chromatogram analysis application was written that manages and archives chemical standards information and provides a basis for NIST traceability for all analyses. Within this same package, all compound calibration response curves are managed and different report formats were incorporated that simplify trend analysis. Test results focus on operation of the original system at the OU 1 Integrated Chemical and Flow Monitoring System at the Fire Drill Area remediation site.
http://www.osti.gov/bridge/product.biblio.jsp?query_id=2&page=0&osti_id=899380

Photodegradation of Polyaromatic Hydrocarbons in Passive Air Samplers: Field Testing Different Deployment Chambers
Bartkow, M.E. (Univ. of Queensland, Coopers Plains, Queensland, Australia), K.E. Kennedy, J.N. Huckins, N. Holling, T. Komarova, and J.F. Mueller.
Environmental Pollution, Vol 144 No 2, p 371-376, Nov 2006

Semi-permeable membrane devices (SPMDs) were loaded with deuterated anthracene and pyrene as performance reference compounds and deployed at a test site in four different chambers (open and closed box chamber, bowl chamber, and cage chamber) for 29 days. The losses of reference compounds and the uptake of polyaromatic hydrocarbons (PAHs) from the ambient air were quantified. UV-B levels measured in each deployment chamber indicated that SPMDs would be exposed to the most UV-B in the cage chamber and open box chamber. Significantly fewer PAHs were quantified in SPMDs deployed in the cage chamber and open box chamber compared to samplers from the other two chambers, suggesting that photodegradation of PAHs had occurred. The loss of reference compounds confirmed these results but also showed that photodegradation was occurring in the closed box chamber. The bowl chamber appears to provide the best protection from the influence of sunlight.
http://www.aseanenvironment.info/Abstract/41013940.pdf

Photolysis-Assisted, Long-Path FT-IR Detection of Air Pollutants in the Presence of Water and Carbon Dioxide
Bacsik, Z. and J. Mink, Hungarian Academy of Sciences, Budapest, Hungary.
Talanta, Vol 71 No 1, p 149-154, 15 Jan 2007

The technique of photolysis-assisted FT-IR spectroscopy renders the spectra of water and carbon dioxide invisible. A cell equipped with a UV lamp was used to oxidize an analyte in an air sample and the spectrum recorded was used as a new background for the original sample spectrum. The optimum UV irradiation time and correctness of the concentrations were determined for this technique and compared with those from traditional methods. The signal-to-noise (S/N) ratios of the so-called "shadow spectra" were comparable to and in some cases better than the S/N ratios in absorbance spectra obtained using an air or an evacuated cell reference as background and subtracting the spectra of water and carbon dioxide from a spectral library. The detection limits for the 8 VOCs investigated have been improved by using this new method that allows an appropriate background spectrum to be obtained quickly. The method is limited in that it cannot be applied to non-UV reactive compounds, such as methane, and the detection limits can be degraded appreciably when bands due to ozone in the shadow spectra overlap those of the compounds under investigation.

Polyurethane Foam (PUF) Disks Passive Air Samplers: Wind Effect on Sampling Rates
Tuduri, L. (Univ. Bordeaux I, Perigueux, France); T. Harner and H. Hung (Environment Canada, Toronto, ON).
Environmental Pollution, Vol 144 No 2, p 377-383, Nov 2006

Different passive sampler housings were evaluated for their wind dampening ability and how this might translate to variability in sampler uptake rates. The effect of outside wind speed on polyurethane foam (PUF) disk sampling rates was evaluated by exposing PUF disks to a PCB-contaminated air stream in a wind tunnel over air velocities in the range 0 to 1.75 m/s. PUF disk sampling rates increased gradually over the range 0-0.9 m/s at ~4.5-14.6 cubic m/d and then increased sharply to about 42 cubic m/d at about 1.75 m/s (sum of PCBs). The results indicate that for most field deployments, the conventional 'flying saucer' housing adequately dampens the wind effect and will yield approximately time-weighted air concentrations.
http://www.aseanenvironment.info/Abstract/41013941.pdf

The Present State of Amperometric Nanowire Sensors for Chemical and Biological Detection
Ervin, M.H., S.J. Kilpatrick, C. Lombardo, B.M. Nichols, A.C. Perrella, and A.E. Wickenden.
ARL-TR-3962, NTIS: ADA458282, 48 pp, Oct 2006

This report reviews the research in chemical sensing at the nanometer scale using amperometric detection, focusing on publications from January 2004 to September 2005. The devices discussed fall into two categories: chemresistors and chemFETs. In either configuration, the number of carriers available in the channel, and hence the device's transconductance, changes as a function of analyte exposure. Devices based on inorganic nanowires (specifically limited to metal oxides and silicon), conductive organic polymer fibers, and carbon nanotubes are discussed as issues of sensitivity, selectivity, and response/refresh times.
http://handle.dtic.mil/100.2/ADA458282

Protocol for Use of Five Passive Samplers to Sample for a Variety of Contaminants in Groundwater
Interstate Technology and Regulatory Council (ITRC) Diffusion/Passive Sampler Team.
Report No: DSP-5, 121 pp, Feb 2007

This guidance contains protocols for five passive sampling technologies. "Passive" sampling is synonymous with "no-purge" sampling. The technologies included in this document include the Snap Sampler™ and Hydrasleeve™ (grab-type well water samplers); a regenerated-cellulose dialysis membrane sampler and a rigid, porous polyethylene sampler (diffusion/equilibrium-type samplers); and the GORE™ Module (a diffusion and sorption-type sampler). These three categories or types of passive samplers have been described in detail in the precursor to this document, Technology Overview of Passive Sampler Technologies (DSP-4, ITRC 2006). The current document was written to provide guidance on how to deploy and collect samples properly using passive devices.
http://www.itrcweb.org/Documents/DSP-5.pdf

Quartz Crystal Microbalance Immunosensor for Highly Sensitive 2,3,7,8-Tetrachlorodibenzo-p-dioxin Detection in Fly Ash from Municipal Solid Waste Incinerators
Aizawa, H., J.-W. Park, and S. Kurosawa, National Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki, Japan.
Analyst, Vol 130 No 11, p 1495-1501, 2005

A quartz crystal microbalance (QCM) immunosensor was developed for the detection of 2,3,7,8-tetrachlorodibenzo-p-dioxins (TCDD) in environmental pollutants. An anti-TCDD antibody was immobilized on the gold surface of the QCM via chemical coupling, and its immunologic activity was then maintained by treatment with an artificial stabilizing reagent such as poly(2-methacryloyloxyethyl phosphorylcholine-co-n-butyl methacrylate). A competitive immunoreaction with TCDD conjugated ovalbumin (TCDD-ovalbumin) was used to detect TCDD. The relationships between GC-MS, ELISA, and QCM were compared using fly ash samples from a municipal solid waste incinerator, and the results are reported.

Rapid and Comprehensive Indicator for Evaluation of Performance of Treatment Processes and of River Waters
Kim, H.K., B.C. Lee, S.D. Kim, T. Kamei, and Y. Magara, National Inst. of Environmental Research, Buk-gu, Gwangju, Korea.
Water Science & Technology, Vol 55 Nos 1-2, p 315-320, 2007

Naturally occurring UV-active compounds, commonly present in almost all source waters, can be rapidly monitored by their ultraviolet absorbance at 260 nm (E260). The extent of correlation between the E260 and the removal efficiency of the hazardous contaminants (e.g., endocrine disrupters and dioxins) was investigated using various treatment and river source waters. The detection of hazardous contaminants using sophisticated analytical methods, such as HRGC/HRMS and HPLC/ICP/MS, as well as various short-term bioassays, can require hours or even days for results to be obtained. The removal of the E260 correlated well with those of individual contaminants with the various treatment processes employed. In the plots of the endocrine disrupters against the DOC/E260, a correlation was found with the endocrine activity of the Korean/Japanese river waters employed in this study.

Rapid Screening for Soil Ecotoxicity with a Battery of Luminescent Bacteria Tests
Heinlaan, M., A. Kahru, K. Kasemets, I. Kurvet, C. Waterlot, K. Sepp, H.C. Dubourguier, F. Douay, National Inst. of Chemical Physics and Biophysics, Tallinn, Estonia.
Alternative Laboratory Animals, Vol 35 No 1, p 101-110, Mar 2007

A bacterial test battery involving (a) Microtox, an aquatic test, (b) the Flash assay, a soil-suspension test (with Vibrio fischeri as the test organism), and (c) the Metal Detector assay, a semi-specific aquatic test for heavy metals (with recombinant luminescent Escherichia coli) was used in a combined toxicological and chemical hazard assessment of soils sampled from a former military airfield and from traffic-influenced roadsides. The soils showed slightly elevated levels of total petroleum hydrocarbons (TPH), but not of heavy metals. In most of the samples, the levels of TPH did not exceed the Estonian permitted limit values set for residential areas. Toxicity testing was performed on both fresh and dried soils after aqueous extraction for 1 hour and 24 hours. The toxicity results obtained with the Microtox test did not differ significantly in any of the sample treatment schemes; however, it appeared that the drying and sieving of the soils increased the bioavailability of toxicants, probably due to an enlarged reactive soil surface area. According to chemical analysis of the soils and the data from the Microtox test and the Metal Detector assay (performed on aqueous elutriates of the soils), these soils would not be considered to be hazardous. In contrast, the Flash assay performed on soil-water suspensions of dried soils, showed that most of the soils were toxic and thus probably contained undetermined particle-bound bioavailable toxicants. The photobacterial toxicity test (the Flash assay) can be recommended for the rapid screening of soils, as it is sensitive and inexpensive and provides valuable information on particle-bound bioavailable toxicants, useful for complementing a chemical analysis and for assessing the risks of polluted soils.

Real-Time Discriminatory Sensors for Water Contamination Events: LDRD 52595 Final Report
Mowry, Curtis D., et al.
SAND2005-6873, 57 pp, Oct 2005

The gas-phase uChemLab™ developed by Sandia can detect volatile organics and semi-volatiles organics via gas-phase sampling. The goal of this 3-year Laboratory Directed Research and Development project was to adapt the components and concepts used by the uChemLab™ system towards the analysis of water-borne chemicals of current concern. In essence, interfacing the gas-phase uChemLab™ with water to bring the significant prior investment of Sandia and the advantages of microfabrication and portable analysis to a whole new world of important analytes, such as chemical weapons agents, their hydrolysis products, and disinfection byproducts (e.g., trihalomethanes (THMs) and haloacetic acids (HAAs)). THMs and HAAs are currently regulated by EPA due to health issues, yet water utilities do not have rapid on-site methods of detection that would allow them to adjust their processes quickly to protect consumers, meet water quality standards, and obey regulations more easily and with greater confidence. This report documents the results, unique hardware and devices, and methods designed during the project and presents and discusses the portable field system to measure THMs developed in the course of this project.
http://www.prod.sandia.gov/cgi-bin/techlib/access-control.pl/2005/056873.pdf

Real-Time Monitoring of Transport of Chlorinated Hydrocarbons from Industrial Areas Using Open-Path FTIR Spectrometry with COL1SB
Hong, DaeWoong and SeogYeon Cho, Inha Univ., Incheon, Korea.
Spectroscopy Letters, Vol 38 No 3, p 303-318, May 2005

Open-path Fourier transform infrared (FTIR) spectrometry was used to monitor 11 chlorinated hydrocarbon species continuously for 24 hours in the region connecting two different industrial complexes. The single-beam spectra obtained from open-path FTIR were analyzed by COL1SB, a new software that generates site-specific background spectra and path-averaged water vapor concentrations in addition to performing regression analyses. The path-averaged water vapor concentrations calculated by the COL1SB agreed very well with those measured by a thermohygrometer. Site-specific background spectra were generated by accounting for chemical absorption of 50 chemical species. The accurate estimation of path-averaged water vapor concentrations, as well as the use of site-specific background spectra, enables chlorinated hydrocarbons to be measured by open-path FTIR spectrometry at the ppb level. Among 11 chlorinated hydrocarbons considered, trichlorofluoromethane, carbon tetrachloride, trichloroethene, and tetrachloroethene were identified as major chlorinated hydrocarbons having concentrations above 1 ppb. Wind affected the temporal variations of these chlorinated hydrocarbons, indicating the importance of local transport; however, the effect of wind differed from one species to another because of different source characteristics.

Remote Sensing Technique for Geoacoustic Characterization of Heterogeneous Marine Sediments
Ivakin, Anatoliy N.
NTIS: ADA464262, 8 pp, Oct 2006

The long term goal of this research is to develop an improved physics-based technique for remote quantification of seafloor geoacoustical properties. The specific scientific tasks of this project were (1) to develop inversion algorithms for estimating the sediment grain size distribution of coarse fractions in sandy sediments based on a recently developed inclusion scattering model, (2) to test these algorithms using the SAXO4 scattering data, and (3) to provide ground truth for such tests by direct measurements of the grain size distribution in the available SAXO4 sediment samples and cores. The tasks were accomplished. An algorithm for scattering data inversions was developed based on a parameterization of the grain size distribution using power law approximations in given intervals of sizes. The algorithm allows inversions of the level and power exponent of the size distribution in each interval. To provide ground truth for testing the algorithm, 13 sediment samples taken at the SAXO4 site were analyzed. Sand grains and shell particles were separated and their number, weight and shape factor were measured in each size interval. It was demonstrated that the SAXO4 acoustic scattering data inversion based on the developed algorithm provides a qualitative fit to the ground truth data.
http://handle.dtic.mil/100.2/ADA464262

Removal of Immiscible Contaminants from Sandy Soils Monitored by Means of Dielectric Measurements
Rinaldi, V.A. and F.M. Francisca, National Univ. of Cordoba, Cordoba, Argentina.
Journal of Environmental Engineering, Vol 132 No 8, p 931-939, Aug 2006

The complex dielectric permittivity of contaminated granular soils was measured during the application of different decontamination processes. The specimens were washed with water, water/surfactant, water/surfactant/alcohol, and water vapor. The complex dielectric permittivity of sand specimens was measured in the frequency range from 20 MHz to 1.3 GHz during the decontamination process. The measured permittivity was compared with that determined for clean and fully contaminated specimens. A theoretical mixture formula was calibrated and implemented to estimate the volume fraction of contaminant present in the pore field. The real permittivity of particle-fluid mixtures was found to increase with the fluid volumetric content, and the dielectric permittivity of silica sand increased with the volumetric content of the fluids.

Research into the Variables Affecting Purge and Trap Collection for a Portable Field Trihalomethane Testing Unit
Irwin, A.N., C.D. Mowry, and T.T. Borek III.
SAND2006-2447, 32 pp, Apr 2006

Sandia National Laboratories has developed a cost-effective portable testing unit to detect volatile organic compounds via purge and trap, gas chromatography, and surface acoustic wave detection. The research discussed in this report investigates some of the variables unique to a portable testing device. During the course of this project, the developers have determined that (1) environmental air can be used as a substitute for helium as a purging gas; (2) the majority of trihalomethane removal occurs during the first five minutes of purging; and (3) a metal reservoir can be used as a substitute for glass.
http://www.osti.gov/bridge/purl.cover.jsp?purl=/883140-0PKQKJ/

A Review of In Situ Measurement of Organic Compound Transformation in Groundwater
Papiernik, S.K.
Pest Management Science, Vol 57, p 325-332, 2001

The potential for organic compounds to be transformed in groundwater has been measured using in situ methods, which avoid problems of attempting to duplicate aquifer conditions in the laboratory. In situ assessments of transformation rates have been accomplished using transport studies and in situ microcosms (ISMs); a review of these methods is provided. In transport studies, organic solutes are injected into an aquifer and the concentrations are monitored as they are transported downgradient. The change in mass of a solute is determined by the area contained under the breakthrough curve (plot of concentration versus time). ISMs isolate a portion of the aquifer from advective flow and act as in situ batch reactors. Experiments using ISMs involve removing water from the ISM, amending it with the solutes of interest, re-injecting the amended water, and monitoring the solute concentrations with time. In both transport and ISM studies, the loss of organic solutes from solution does not allow a distinction to be made between sorptive, abiotic and biotic transformation losses. Biological activity can be chemically suppressed in ISMs and the results from those experiments used to indicate sorption and abiotic loss. Transformation products may be monitored to provide additional information on transformation mechanisms and rates.
http://www.ars.usda.gov/SP2UserFiles/Place/36450000/Products-Reprints/2001/1149.pdf

Review of State of the Art Methods for Measuring Water in Landfills
Imhoff, P.T. (Univ. of Delaware, Newark), D.R. Reinhart, M. Englund, R. Guerin, N. Gawande, B. Han, S. Jonnalagadda, T.G. Townsend, and R. Yazdani.
Waste Management, Vol 27 No 6, p 729-745, 2007

Several types of sensors and measurement techniques have been developed for measuring the moisture content, water saturation, or the volumetric water content of landfilled wastes, and the most promising techniques are reviewed. The basic principles behind each technique are discussed and field applications of the techniques are presented, including cost estimates. Previously unpublished data are provided for several sensors. Neutron probes, electrical resistivity (impedance) sensors, time domain reflectometry (TDR) sensors, and the partitioning gas tracer technique (PGTT) were field tested with results compared to gravimetric measurements or estimates of the volumetric water content or moisture content. Neutron probes were not able to measure the volumetric water content accurately, but could track changes in moisture conditions. Electrical resistivity and TDR sensors tended to provide biased estimates, with instrument-determined moisture contents larger than independent estimates. While the PGTT resulted in relatively accurate measurements, electrical resistivity and TDR sensors provide more rapid results and are better suited for tracking infiltration fronts. Fiber optic sensors and electrical resistivity tomography hold promise for measuring water distributions in situ, particularly during infiltration events, but have not been tested with independent measurements to quantify their accuracy. Additional work is recommended to advance the development of some of these instruments and to acquire an improved understanding of liquid movement in landfills by application of the most promising techniques in the field.
http://www.aseanenvironment.info/Abstract/41014831.pdf

ROC-Curve Approach for Determining the Detection Limit of a Field Chemical Sensor
Fraga, C.G., A.M. Melville, and B.W. Wright.
Analyst, Vol 132 No 3, p 230-236, 2007

The detection limit of a field chemical sensor under realistic operating conditions is determined by receiver operator characteristic (ROC) curves. The chemical sensor is an ion mobility spectrometry (IMS) device used to detect a chemical marker in diesel fuel. The detection limit is the lowest concentration of the marker in diesel fuel that obtains the desired true-positive probability (TPP) and false-positive probability (FPP). A TPP of 0.90 and a FPP of 0.10 were selected as acceptable levels for the field sensor in this study. The detection limit under realistic operating conditions is found to be between to 2 to 4 ppm (w/w). The upper value is the detection limit under challenging conditions. The ROC-based detection limit is very reliable because it is determined from multiple and repetitive sensor analyses under realistic circumstances. ROC curves also illustrate and gauge the effects data preprocessing and sampling environments have on the sensor's detection limit.

The Role of XRPD Analyses in the Investigation of COPR Mineralogy During Treatment: A Case Study
Dermatas, D., S. Pardali, M. Chrysochoou, D.H. Moon, and D.G. Grubb, Stevens Inst. of Technology, Castle Point on Hudson, Hoboken, NJ.
Protection 2006: Proceedings of Protection and Restoration of the Environment VIII, Chania, Crete, Greece, 3-7 July 2006. Scientific References COSMOS, 8 pp, 2006

X-ray powder diffraction (XRPD) analyses were applied to untreated and treated chromite ore processing residue (COPR) to assess the quantitative mineralogical composition of

the waste matrix and evaluate the phase transformations occurring in COPR upon addition of ferrous sulfate heptahydrate during treatment. Geochemical instability of both matrices was indicated due to the presence of thermodynamically unstable phases. Excess quantities of ettringite in the treated matrix were linked with the observed swell phenomena. XRPD identified the speciation of the hexavalent Cr, but the complexity of the COPR mineralogical system introduced limitations to the effectiveness of the method.
http://www.ath.aegean.gr/srcosmos/showpub.aspx?aa=8311

Sampling Technologies and Air Pollution Control Devices for Gaseous and Particulate Arsenic: A Review
Helsen, Lieve, Katholieke Univ. Leuven, Heverlee, Belgium.
Environmental Pollution, Vol 137 No 2, p 305-315, Sep 2005

Direct measurement of arsenic release requires a good sampling and analysis procedure to capture and detect the total amount of metals emitted. The literature was extensively reviewed to evaluate the efficiency of full-scale field and laboratory techniques for capturing particulate and gaseous emissions of arsenic from the thermochemical treatment of different sources of arsenic. Trace arsenic concentrations in ambient air, national standard sampling methods and arsenic analysis methods are considered. Besides sampling techniques, the use of sorbents is also reviewed with respect to both approaches (1) to prevent the metals from exiting with the flue gas and (2) to react or combine with the metals in order to be collected in air pollution control systems. The most important conclusion is that submicron arsenic fumes are difficult to control in conventional air pollution control devices. Complete capture of the arsenic species requires a combination of control devices for particles and vapor.
http://www.aseanenvironment.info/Abstract/41012243.pdf

Screening of PAHs and DDTs in Sand and Acrisols Soil by a Rapid Solid-Phase Microalgal Bioassay
Chung, M.K., R. Hu, K.C. Cheung, and M.H. Wong, Hong Kong Baptist Univ., Kowloon, Hong Kong SAR, P.R. China.
Ecotoxicology, Vol 16 No 5, p 429-438, July 2007

Previous work demonstrated the rapid screening potential of a newly developed solid-phase microalgal bioassay with spiked sands. Additional comparative results have been obtained using sands and field-collected acrisols soils spiked with both PAHs and DDT. Toxicity responses obtained from standard higher plant tests with three species of plants were compared with those obtained from a cocktail of microalgae. The 5-day seed germination/root elongation tests were not sensitive at all in contrast to the 4-day solid-phase microalgal tests and the 28-day early seedling growth tests in both spiked sands and contaminated soils. Sensitivities of microalgal tests were generally higher than the seedling growth tests in spiked sands. The responses of microalgae and higher plants varied in assays with contaminated soil, but the results demonstrated that microalgae generally could act as effective surrogates to screen xenobiotic compounds at levels toxic to higher plants, with C. meneghini especially sensitive to reveal phytotoxic effects. This promising rapid screening solution could be used with standard seedling growth tests when assessing phytotoxicities of contaminated areas, especially for acrisols soil.

Screening of Volatile Organic Compounds as a Source for Indoor Pollution
Zabiegala, B., M. Partyka, A. Gawronska, A. Wasilewska, and J. Namiesnik, Gdansk Univ. of Technology (GUT), Gdansk, Poland.
International Journal of Environment and Health, Vol 1 No 1, p 13-28, 2007

The authors review potential sources of volatile organic compounds (VOCs) in indoor air, with a particular emphasis on building materials and the materials used for finishing work. A screening methodology and test chamber protocols are presented that allow the determination of VOC fluxes from the materials inside a building.

http://www.inderscience.com/storage/f541082111691273.pdf

Selective Binding of Organophosphate Pesticides Using Molecular Imprinted Polymers
Saboori, A.M. and R.K. Gordon.
FASEB Journal, Vol 17 No 4 pt. 1, p A586, 2003 [NTIS: ADA449756]

Molecular imprinted polymers (MIPs) have been used for recognition and binding of different compounds. MIPs are being developed to selectively bind organophosphate pesticides and toxic chemical warfare nerve agents. MIPs were made to the pesticide Dichlorvos. Control MIPs were made without the template. Dichlorvos MIPs bound more Dichlorvos in comparison to control MIPs. The Dichlorvos MIPs can be regenerated after binding the pesticide and reused at least three times by repeating the washing procedure. Dichlorvos MIPs demonstrated specificity for its template as they did not bind Methamidophos, Phosdrin, and Metasystox I, which are compounds with chemical structures similar to that of Dichlorvos.

http://handle.dtic.mil/100.2/ADA449756

Simple and High-Sensitivity Detection of Dioxin Using Dioxin-Binding Pentapeptide
Inuyama, Y. (Towa Kagaku Co. Ltd., Naka-ku, Hiroshima, Japan); C. Nakamura; T. Oka; Y. Yoneda; I. Obataya; N. Santo; J. Miyake.
Biosensors and Bioelectronics, Vol 22 Nos 9-10, p 2093-2099, 15 Apr 2007

A study was conducted to construct a simple dioxin detection system using peptides that bind to dioxin, and to test the system on real environmental samples. Dioxin and N-NBD-3-(3′,4′-dichlorophenoxy)-1-propylamine were competitively bound to the peptides synthesized on beads. The fluorescence intensity of the bead decreased with increasing dioxin concentration. The concentration of dioxin was determined by measuring the fluorescence intensity using a fluorescence microscope equipped with a CCD camera. The fluorescence microscope system was equipped with a motor-driven stage and could be used with 96-well microplates and analytical software that automatically measured the fluorescence intensity of the bead images in the wells. About 0.5 nM (150 pg m/L) of 2,3,7,8-TCDD could be detected under the optimized conditions. Environmental soil samples were subjected to the detection system using the peptide beads. The results obtained correlated poorly with the toxicity equivalency quantity (TEQ) concentration obtained by a GC/MS method; nevertheless, the method is sufficiently robust to use as a prescreening method to detect at least 250 pg-TEQ/g, the survey level for soil requiring special measures against dioxins in Japan.

Smart Dust Sensors for Remote Detection of Chem/Bio Agents
Bachand, George David.
Defense Advanced Research Projects Agency Project Meeting, 7-8 February 2006, Arlington, VA. SAND2006-0710C, 18 pp, 2006

The overall goal of this project is to develop a chem/bio sensor that is (1) powered exclusively by biomolecular motors (kinesin and microtubules) and chemical energy (ATP), (2) able to detect a range of chemical and biological agents, (3) capable of remote detection by unmanned aerial vehicles, (4) deployable as "smart dust" on target battlefields, and (5) capable of multiplexing for multiple target analytes. In the consortium of five institutes to address this goal, our role is to work on the long-term survival of the kinesin motor and other components of the smart dust sensor.

Source Characterization Using a Membrane Interface Probe in Conjunction with Depth-Specific Sampling
Langenbach, J. (Geosyntec Consultants, Titusville, FL); A. Montgomery; R.S. Ebaugh.
The Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, (Monterey, CA; May 2006): Book of Abstracts. Battelle Press, Columbus, OH. 2006

The membrane interface probe (MIP), used in conjunction with mobile laboratory discrete interval soil and groundwater sampling based upon the MIP response data, can be used to assess the lateral and vertical distribution of volatile organic compound source areas, evaluate the presence or absence of DNAPL, and assist with the selection of cost-effective remedial solutions. The MIP is a good technique for profiling the concentration gradients of volatile organics with depth, enabling the user to define specific impacted intervals with follow-up discrete interval sampling to quantitatively evaluate the contaminant mass. This presentation addresses the use of MIP technology during waste characterization associated with the remediation of soils and sediments near the Hypergol Support Building at Kennedy Space Center to delineate areas designated for in situ treatment or excavation. In conjunction with DPT soil and groundwater sampling, the MIP data were used to delineate a 9,500 sq ft source area with a calculated trichlorofluoromethane mass of 342 lbs, facilitate the selection of air sparging as the appropriate remedial technology, and provide valuable data for designing the air sparge system for remediation of the source area.

Spectroelectrochemical Sensor for Pertechnetate Applicable to Hanford and Other DOE Sites
Heineman, William R., C.J. Seliskar, S.A. Bryan, A.S. Del Negro, and T.L. Hubler.
ERSD-90076-2006, 6 pp, June 2006

The general aim of this DOE-funded work is the design and implementation of a new sensor technology that offers the levels of specificity needed for analysis of complex chemical mixtures. The sensor is based on a unique combination of electrochemistry, spectroscopy, and selective partitioning into a film that collectively provide an extraordinary level of selectivity for the target analyte. The goal is a reversible sensor in which the fluorescent Tc-complex formed in the film is re-oxidized to $TcO_4^-$ and free ligand. $TcO_4^-$ in the film would then re-equilibrate with the sample. The sensor would satisfy requirements for both applications described above. Making significant progress towards this goal has required the discovery of new chemistry and spectroscopy for technetium itself, including the first technetium complexes that fluoresce in solution at room temperature.
http://www.osti.gov/em52/2006projsum/90076.pdf

A System for Calibrating Seepage Meters Used to Measure Flow Between Ground Water and Surface Water
Rosenberry, D.O. and Michael A. Menheer
U.S. Geological Survey, Scientific Investigations Report 2006-5053, 27 pp, 2006

A system has been developed for generating controlled rates of seepage across the sediment/water interface representing flow between groundwater and surface water. The seepage-control system facilitates calibration and testing of seepage measurement devices commonly called seepage meters. Two slightly different seepage-control systems were evaluated. Both designs make use of a 1.5-m-diameter by 1.5-m-tall polyethylene flux tank partially filled with sand that overlies a pipe manifold and diffuser plate to provide a uniform flux of water through the sand. The flux tank is filled with water to maintain a water depth above the sand bed of about 0.6 m. Flow is generated by routing water through tubing that connects an adjustable-height reservoir to the base of the flux tank, through the diffuser plate and sand, and across the sediment-water interface. Seepage rate is controlled by maintaining a constant water depth in the reservoir while routing flow between the reservoir and the flux tank. The rate of flow is controlled by adjusting the height of the reservoir with a manually operated fork lift. Flow from groundwater to surface water (inflow) occurs when the water surface of the reservoir is higher than the water surface of the flux tank. Flow from surface water to groundwater (outflow) occurs when the water surface of the reservoir is lower than the water surface of the flux tank. Flow rates as large as +/-55 centimeters per day were generated by adjusting the reservoir to the extremes of the operable range of the fork lift. The minimum seepage velocity that the flowmeter can reliably measure is about 7 centimeters per day. Water in the reservoir is maintained at a nearly constant depth by pumping return flow between the reservoir and flux tanks based on output from a submersible pressure transducer placed in the reservoir. A datalogger switches the pump on and off at appropriate intervals to maintain a nearly constant water depth inside the reservoir, which maintains a virtually constant hydraulic gradient between the reservoir and flux tanks. The datalogger also records flow, in units of volume per time, as measured by an in-line flowmeter positioned between the base of the flux tank and the reservoir. Seepage flux in units of distance per time is determined by dividing the flowmeter output by the surface area at the sediment/water interface in the flux tank. Spatial heterogeneity in seepage was evident in both flux tanks in spite of attempts to minimize heterogeneity during tank construction. Medium sand was used in both flux tanks and care was taken to homogenize the sand during and after filling of the tanks. Time was provided for release or dissolution of trapped air, and water was circulated to remove fine-grained sediments prior to system use. In spite of these precautions, seepage measured with five to six small 20.25-cm-diameter seepage meters varied by about a factor of two. Use of larger diameter seepage meters, which cover a larger percentage of the sediment surface of the flux tanks, greatly minimized measured seepage heterogeneity. The seepage-control system was used to demonstrate that seepage-meter efficiency is sensitive to the type of seepage-meter bag and that bag-measured seepage rate is sensitive to the duration of the seepage-meter measurement only during very short measurement times. The in-line flowmeter used with this system is incapable of measuring seepage rates below about 7 centimeters per day. Smaller seepage rates can be measured manually. The seepage-control system also can be modified for measuring slower seepage rates with the use of two flowmeters and a slightly different water-routing system, or a fluid-metering pump can be used to control flow through the flux tank instead of an adjustable-height reservoir.
http://pubs.usgs.gov/sir/2006/5053/

Systematic Evaluation of Satellite Remote Sensing for Identifying Uranium Mines and Mills
Stork, Christopher L., Heidi A. Smartt, Dianna S. Blair, and Jody L. Smith.
SAND2005-7791, 64 pp, Jan 2006

The authors systematically evaluate the ability of current-generation, satellite-based spectroscopic sensors to distinguish uranium mines and mills from other mineral mining and milling operations by (1) outlining the remote, spectroscopic signal generation process, (2) documenting the capabilities of current commercial satellite systems, (3) systematically comparing the uranium mining and milling process to other mineral mining and milling operations, and (4) identifying the most promising observables associated with uranium mining and milling that can be identified using satellite remote sensing. The Ranger uranium mine and mill in Australia serves as a case study for applying and testing the techniques developed in this systematic analysis. Based on literature research of mineral mining and milling practices, a decision tree is developed that utilizes the information contained in one or more observables to determine whether uranium is possibly being mined and/or milled at a given site. Promising observables associated with uranium mining and milling at the Ranger site included in the decision tree are uranium ore, sulfur, the uranium pregnant leach liquor, ammonia, and uranyl compounds and sulfate ion disposed of in the tailings pond. Based on the size, concentration, and spectral characteristics of these promising observables, an evaluater then determines whether these observables can be identified using current commercial satellite systems, namely Hyperion, ASTER, and Quickbird. The only promising observables at Ranger that can be uniquely identified using a current commercial satellite system (notably Hyperion) are magnesium chlorite in the open pit mine and the sulfur stockpile. Based on the identified magnesium chlorite and sulfur observables, the decision tree narrows the possible mineral candidates at Ranger to uranium, copper, zinc, manganese, vanadium, the rare earths, and phosphorus, all of which are milled using sulfuric acid leaching.
http://www.prod.sandia.gov/cgi-bin/techlib/access-control.pl/2005/057791.pdf

Trace Level Determination of Perchlorate in Soils and Saltwater by Tandem Suppressed Conductivity and Mass Spectrometry (IC/MS)
Gandhi, J. (Metrohm-Peak Inc., Houston TX) and M. Johnson (USEPA Region 6, Houston TX).
NEMC 2006: The 22nd Annual National Environmental Monitoring Conference, Arlington, Virginia, 28-31 August 2006. 37 pp, 2006

This presentation contains overviews and comparisons of perchlorate analysis using the following USEPA methods: Method 314 -- suppressed conductivity, Method 314.1 -- Matrix elimination and pre-concentration, Method 332.0 -- ICMS and ICMSMS, and Method 331.0 -- LCMS and LCMSMS.
http://nemc.us/proceedings/2006/06T70ppt.pdf

Tracer Tests as a Mean of Remediation Procedures in Mines
Wolkersdorfer, Christian, TU Bergakademie Freiberg, Freiberg/Sachsen, Germany.
Uranium in the Environment: Mining Impact and Consequences. Springer, ISBN: 978-3-540-28363-8, p 817-822, 2006

In the literature, the difficulties in evaluating the hydrodynamics of flooded mines has been well described, although only few descriptions of tracer tests in flooded mines have been published so far. Most tracer tests linked to mine water problems were related to either pollution of the aquifer or radioactive waste disposal and not the mine water itself. Applying the results of the tracer test provides possibilities for optimizing the outcome of the source/path/target methodology and can diminish the costs of remediation strategies for acid mine drainage or metals contamination. Relatively cheap and reliable results for decision making can be obtained by the use of tracer tests prior to planning remediation strategies or numerical simulations.

A Two-Dimensional Ion Chromatographic Method for the Ultra-low Level Determination of Perchlorate and Bromate Using Suppressed Conductivity Detection
Later, Douglas, Rong Lin, Brian DeBorba, Kannan Srinivasan, and Chris Pohl.
NEMC 2006: The 22nd Annual National Environmental Monitoring Conference, Arlington, Virginia, 28-31 August 2006, 28 pp, 2006

The new 2-D method has the following features. (1) Allows for large loop injection in the first dimension (4-mm column). It is possible to inject a larger loop than the standard approach since the capacity and selectivity of the analytical column in the first dimension dictates the recovery, and the analyte of interest is analyzed in the second dimension. (2) Focuses the ions of interest in a concentrator column after suppression in the first dimension; hydroxide eluent is suppressed to D.I. water, thus providing an ideal environment for focusing or concentrating the ions of interest. (3) Pursues analysis in the second dimension using a smaller column format operated at a lower flow rate, leading to sensitivity enhancement that is proportional to the flow rate ratio. For a 4-mm column operated in the first dimension at 1 mL/min and a 2-mm column operated in the second dimension at 0.25 mL/min, the enhancement factor is 4. (5) Easy implementation on through state-of-the-art IC instrumentation, the ICS-3000 System for Automated 2-D IC.
http://nemc.us/proceedings/2006/06T69ppt.pdf

Ultrasonic Solvent Extraction of Organochlorine Pesticides from Soil
Tor, A., M.E. Aydin, and S. Ozcan, Selcuk Univ., Konya, Turkey.
Analytica Chimica Acta, Vol 559 No 2, p 173-180, 16 Feb 2006

The authors report on the ultrasonic solvent extraction of organochlorine pesticides (OCPs) including HCH, heptachlor, aldrin, DDE, dieldrin, DDT, methoxychlor, and mirex from soil. Determination of pesticides was carried out by gas chromatography (GC) equipped with electron capture detection (ECD). Twice ultrasonic extraction using 25mL of a mixture of petroleum ether and acetone (1/1 v/v) for 20 min of sonication showed satisfactory extraction efficiency. Recoveries of pesticides from fortified soil samples are over 88% for three different fortification levels between 15 and 200 ug/kg, and relative standard deviations of the recoveries are generally below 6%. Real soil samples were analyzed for OCP residues by optimized ultrasonic solvent extraction and shake-flask as well as soxhlet extraction technique. Investigated extraction methods showed comparable extraction efficiencies. Optimized ultrasonic solvent extraction is the most rapid procedure because the use of time in ultrasonic extraction was considerably reduced compared to shake-flask and soxhlet extraction.
http://www.aseanenvironment.info/Abstract/41012668.pdf

Use of a General Toxicity Test to Predict Heavy Metal Concentrations in Residential Soils
Aelion, C.M. and H.T. Davis, Univ. of South Carolina, Columbia.
Chemosphere, Vol 67 No 5, p 1043-1049, Mar 2007

Because it is expensive to measure the concentrations of individual metals in large numbers of environmental samples, the general Microtox toxicity test was used to identify highly toxic soil samples. Approximately 100 soil samples were collected from residential areas and analyzed to determine an effective concentration (EC(50)) of soil required to inhibit 50% light emission of the luminescent bacterial test organism (Vibrio fischeri). The EC(50) values were then transformed to relative toxicity units (RTU). A subset of 56 high and low toxicity soil samples was analyzed by inductively coupled plasma-atomic emission spectrometry (EPA method 6010) for arsenic, lead, and chromium. The highest measured arsenic concentration was 30 times higher than the South Carolina residential soil limit. Significant correlations were found between the RTU and soil arsenic and chromium concentrations. Microtox also identified some low arsenic and chromium samples as toxic, presumably because additional unidentified toxicants were present in the soil. In general, the Microtox test was effective in identifying soils with elevated concentrations of arsenic and chromium, even in residential neighborhoods where limited soil toxicity was expected.

Use of Borehole-Radar Methods to Monitor a Steam-Enhanced Remediation Pilot Study at a Quarry at the Former Loring Air Force Base, Maine
Gregoire, Colette, Peter K. Joesten, and John W. Lane, Jr.
U.S. Geological Survey Scientific Investigations Report 2006-5191, 35 pp, 2007

Single-hole radar reflection and crosshole radar tomography surveys were used in conjunction with conventional borehole-geophysical methods to evaluate the effectiveness of borehole-radar methods for monitoring the movement of steam and heat through fractured bedrock. The U.S. Geological Survey, in cooperation with U.S. EPA, conducted surveys in an abandoned limestone quarry at the former Loring Air Force Base during a field-scale, steam-enhanced remediation (SER) pilot project conducted to study the viability of SER to remediate nonaqueous-phase liquid contamination in fractured bedrock. Numerical modeling and field experiments indicate that borehole-radar methods have the potential to monitor the presence of steam and to measure large temperature changes in the limestone matrix during SER operations. Based on modeling results, the replacement of water by steam in fractures should produce a decrease in radar reflectivity (amplitude of the reflected wave) by a factor of 10 and a change in reflection polarity. In addition, heating the limestone matrix should increase the bulk electrical conductivity and decrease the bulk dielectric permittivity. These changes result in an increase in radar attenuation and an increase in radar-wave propagation velocity, respectively. Single-hole radar reflection and crosshole radar tomography data were collected in two boreholes using 100-megahertz antennas before the start of steam injection, about 10 days after the steam injection began, and 2 months later, near the end of the injection. Fluid temperature logs show that the temperature of the fluid in the boreholes increased by 10 degrees C in one borehole and 40 degrees C in the other; maximum temperatures were measured near the bottom of the boreholes. The results of the numerical modeling were used to interpret the borehole-radar data. Analyses of the single-hole radar reflection data showed almost no indication that steam replaced water in fractures near the boreholes because (1) no change of polarity was observed in the radar reflections; (2) variations in the measured traveltimes were unsubstantial; and (3) most of the observed decreases in reflectivity were too small to have resulted from the replacement of water

by steam. Analyses of the crosshole radar tomography data also support the conclusion that steam did not replace water in the fractures around the boreholes because travel-time-difference and attenuation-difference tomograms showed only small decreases in velocity and small increases in attenuation accompanying the steam injection. The radar data are consistent with an increase in the conductivity of the limestone as a result of heating of the limestone matrix near the boreholes. Single-hole radar reflection data collected near the end of the steam injection near the bottom of the borehole with the largest temperature increase showed substantial attenuation. Also, reflector analysis showed small decreases in the amplitudes of radar-wave reflections in data collected before injection and data collected near the end of the collection period. In the crosshole radar tomography data, decreases in velocity and small increases in attenuation also are consistent with temperature increases in the matrix.
http://pubs.usgs.gov/sir/2006/5191/

Use of Stable Isotope Analysis to Assess Biodegradation of Volatile Organic Compounds in the Unsaturated Subsurface
Bouchard, Daniel, Ph.D. dissertation, University of Neuchatel, Switzerland. 141 pp, 2007

The general aim of the project is to evaluate the feasibility of using compound-specific isotope analysis to assess biodegradation of petroleum hydrocarbons in the unsaturated zone. The first objective was to quantify the isotope enrichment factors during biodegradation of several volatile organic compounds (VOCs) commonly found on petroleum hydrocarbon- contaminated sites. These microcosm experiments were carried out with unsaturated soil sediments under aerobic conditions. The results confirmed the possibility to monitor an isotope enrichment in the remaining VOCs in the air phase. The magnitude of isotope enrichment factors was small for carbon and large for hydrogen. A column experiment was carried out to investigate the possible role played by diffusion in the isotope fractionation of migrating VOC vapors. During an initial period after source emplacement, the heavy isotope 13C became increasingly depleted with distance from the source. Later, the isotope profile leveled out, and for some compounds, an enrichment of 13C with distance was observed, indicating biodegradation. Some compounds, however, were also affected by an enrichment of 13C at the source as the compounds were depleting from the source. The source isotope evolution of these compounds followed a Rayleigh trend with the ratio of diffusion coefficients for molecules with a different isotopic composition as isotope fractionation factor. A controlled field experiment provided a unique opportunity to evaluate if similar isotope trends also occur at the field scale. The experiment consisted of burying an artificial fuel source in the unsaturated zone of a sandy aquifer. Isotope evolution similar to the lab study was observed, with an initial depletion of 13C with distance followed by a leveling out of the isotope profile and enrichment of 13C. To evaluate the relative contribution of diffusion and biodegradation on isotope shifts in more detail, the concentration and isotope ratio evolution was simulated using a modified numerical code (MOFAT). The study demonstrates that assessment of biodegradation in the unsaturated zone is more complex than in the saturated zone because the diffusion process influences isotope ratios as well. Under steady-state conditions and as long as the compound does not deplete significantly, isotope data can provide qualitative and possible quantitative information on the degree of biodegradation. While the substantial shift of isotope ratios during source depletion complicates the identification of biodegradation trends, it may help to identify the final stage of the evolution of a VOC source.
http://doc.rero.ch/lm.php?url=1000,40,4,20070228162911-CU/these_BouchardD.pdf

Viral Vectors for Gene Modification of Plants as Chem/Bio Sensors
Manginell, Monica, Dulce Arango, Patricia Dolan, Jason Harper, and Susan Brozik.
SAND2006-6955, 18 pp, Nov 2006

A plant-based sensor technology utilizes mature and seedling plants as chemical sensors. In this one-year project, an inducible expression system was developed to show the feasibility of plant sensors. The vector was designed as a safe, non-infectious vector which could be used to invade, replicate, and introduce foreign genes into mature host plants that then allow the plant to sense chem/bio agents. The genes introduced through the vector included a reporter gene that encodes for green fluorescent protein (GFP) and a gene that encodes for a mammalian receptor that recognizes a chemical agent. Specifically, GFP was induced by the presence of 17-beta-Estradiol (estrogen). Detection of fluorescence indicated the presence of the target chemical agent. Because the sensor is a plant, costly device packaging development or manufacturing of the sensor were not required. Additionally, the biological recognition and reporting elements are maintained in a living, natural environment and therefore do not suffer from lifetime disadvantages typical of most biosensing platforms. Detection of the GFP chem/bio agent reporter can be detected only at a specific wavelength.
http://www.prod.sandia.gov/cgi-bin/techlib/access-control.pl/2006/066955.pdf

## SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) AWARDS

Real-Time Transformer Oil Polychlorinated Biphenyl Sensor (EPA 2007 SBIR Phase 2)
Investigator: Carl R. Evenson, 303-530-0263, info@eltronresearch.com
Company: Eltron, Boulder, CO
Contract: EPD07082
Project Period: May 1, 2007 through April 30, 2009
Project Amount: $212,294

Analysis of PCB concentration is currently performed by SW-846 Method 8082 standard method in an analytical laboratory using gas chromatography. This type of analysis is time consuming and costly. For this offsite analysis, oil must be removed from the transformer, which potentially exposes workers and the environment to PCBs. Eltron is developing a new, portable real-time sensor that can be used on site to quantify the PCBs that are present and determine PCB concentration. In the EPA Phase I SBIR project, Raman spectroscopy and multivariate analysis were combined to create a rapid in situ sensor capable of a simultaneous detection of PCB concentration and composition within transformer oil. Regression models were prepared that could detect PCB concentrations as low as 5 ppm, and classification models were prepared that could predict the type of Aroclor present in transformer oil. During the Phase II project, sensor sensitivity will be improved by testing all major transformer oil types and accounting for appropriate interferences. Surface-enhanced Raman spectroscopy will be used to lower the sensor detection limit, and a prototype instrument (including user-friendly software) will be prepared for field testing. The final product of this project will be a real-time sensor that is cost effective, portable, user friendly, and most importantly will reduce the hazardous removal and transportation of contaminated transformer oil for PCB analysis. The expected instrument capital cost is equivalent to current GC costs ($30K); however, the per-sample testing cost will be significantly less than GC methods. This type of hand-held sensor will find extensive use by electric utilities (Sacramento Municipal Utility District) and hand-held Raman instrument manufacturers (Raman Systems, Inc.). An expected global market of $119 M is expected for this type of instrument by 2009.

Membrane Preconcentrator for Portable Trace VOC Detectors (EPA 2007 SBIR Phase 2)

| | |
|---|---|
| Investigator: | Haiqing Lin, 650-328-2228, hlin@che.utexas.edu |
| Company: | Membrane Technology and Research Inc., Menlo Park, CA |
| Contract: | EPD07085 |
| Project Period: | May 1, 2007 through April 30, 2009 |
| Project Amount: | $224,908 |

A volatile organic compound (VOC) detection system that is portable, sensitive to the low-ppb level, and able to provide reliable measurements in real time is needed for environmental compliance monitoring and process control in chemical plants. Recently, hand-held and battery- powered ppb-level VOC photoionization detectors (PID) have become commercially available, but the presence of water in the sample air interferes with the detection accuracy in PIDs. This project describes the development of a membrane device to remove water vapor from the gas being sent to portable PID-based VOC detectors. The membrane uses a water-permeable, VOC-rejecting perfluoro polymer. The membrane device is compact, lightweight, and energy efficient, which makes it convenient to integrate into a portable detection system. To reduce relative humidity in the air from 100% to 10% while sending 200 mL/min gas to the detector, a membrane with an area of 0.1 sq m is required. In the Phase I project, membranes with the required permeability and selectivity were prepared and made into bench-scale modules with various configurations and the required membrane area of 0.1 sq m. These modules were evaluated for nitrogen/toluene separation, and the configuration was optimized to achieve better separation performance. In addition to removing water from the air, these modules have been demonstrated to enrich VOC content by 10- to 100-fold in the gas sent to the detector. In Phase II, module configurations will be optimized using more innovative designs for improved water removal performance, and a prototype membrane device will be constructed for delivery to business partner RAE Systems, Inc., for testing and evaluation. Integrating such a membrane device with a hand-held, ppb-level VOC detector, such as the ppbRAE Plus detector made by RAE Systems, adds only 30-40% by volume and 100% by weight, which would provide an easily portable system with much improved performance.

Acrolein Monitor Using Quantum Cascade Laser Infrared Absorption (EPA 2007 SBIR Phase 2)

| | |
|---|---|
| Investigator: | Joanne H. Shorter, 978-663-9500 X 208, shorter@aerodyne.com |
| Company: | Aerodyne Research Inc., Billerica, MA |
| Contract: | EPD07077 |
| Project Period: | May 1, 2007 through April 30, 2009 |
| Project Amount: | $225,000 |

Acrolein (CH2 = CHCHO) is a toxic unsaturated aldehyde that has been classified as a hazardous air pollutant by U.S. EPA because of its adverse health effects, particularly on respiratory systems. There is a need for air quality instrumentation for acrolein for routine air quality monitoring in urban areas for health effect assessment and at specific sites for source assessment studies. EPA Region 10 has identified the development of a measurement technique for monitoring acrolein as a priority issue. In the Phase I program, we demonstrated the feasibility of a quantum cascade (QC) laser-based system for acrolein measurement, offering fast response and high sensitivity (~1 ppbv, 1 sec). The instrument is based on tunable infrared laser differential absorption spectroscopy (TILDAS) using QC lasers. The QC-TILDAS method has distinct advantages over indirect detection methods. Infrared absorption is an absolute, highly specific technique. In the Phase I program, we identified the optimum spectral region for acrolein monitoring; investigated and identified background suppression methods with chemical scrubbers to remove interferences from the acrolein measurements, critical to achieving sensitive acrolein detection; and conducted laboratory studies of ambient and source emissions of acrolein. The objective of Phase II is to fabricate and demonstrate a fully functional, fast response, cryogen-free QC laser spectrometer to measure acrolein. The instrument will have compact size to fit in a rack-mountable box and will be capable of long-term, autonomous operation in the field. It will be able to obtain sensitivities in the parts-per-billion (ppbv) range for source monitoring and sub-ppbv range for ambient conditions. There is a need for commercially available air quality instrumentation for acrolein and other toxic air pollutants. The QC-TILDAS system to be built and demonstrated in this program will have wide commercial applications for both routine air quality monitoring and for source assessment of hazardous air pollutants.

### Handheld MEMS-Based Detector of Toxins and Toxigenic Organisms Indicative of Harmful Algal Bloom (EPA 2007 SBIR Phase 1)

Investigator:
Company: Seacoast Science, Carlsbad, CA.
Contract: EPD07057
Project Period: March 1, 2007 through August 31, 2007
Project Amount: $69,971

Seacoast Science proposes the extension of MEMS-based sensor technology to provide near real-time detection, identification, and quantification of toxins and toxigenic organisms indicative of cyanobacteria harmful algal blooms (cyanoHABs) in drinking water to provide administrators the information for public safety. Different monoclonal antibody conjugates will be mapped onto each sensor using a proprietary inkjet deposition process. Both the selective and nonselective binding of the antigen (toxin) with the mAb-C conjugate array will result in a change in dielectric properties of the sensor matrix that will be detected and processed, giving appropriate readings. Specificity inherent in the antigen-antibody binding should limit the fraction of false positives and the use of redundant sensors should lower the fraction of false negatives. The nature of the proposed system allows for rapid analysis (</=10 minutes) with immediate display and optional linking (remotely or directly) of the signal to a computer system for automated reading and storage.

### Improved Rapid Detection of Viable Waterborne Pathogens (EPA 2007 SBIR Phase 2)

Investigator: Richard A Montagna, 716-773-4232, rmontagna@ibi.cc
Company: Innovative Biotechnologies International, Inc., Grand Isle, NY
Contract: EPD07084
Project Period: May 1, 2007 through April 30, 2009
Project Amount: $224,999

The successfully completed Phase I efforts demonstrated that exceedingly low numbers (five or less) of oocysts from human pathogenic strains of Cryptosporidium, including C. parvum and C. hominis can be detected in drinking water using the isothermic Nucleic Acid Sequence

Based Amplification (NASBA) method combined with a rapid liposome nanovesicle-based biosensor technology. Additionally, the CryptoDetect™ Test System that has been developed can distinguish viable from nonviable oocysts and can correctly detect low number of C. parvum, even in the presence of overwhelming numbers of other contaminating waterborne pathogens. In direct head-to-head comparison against Method 1622, the CryptoDetect™ Test System yielded equivalent results. The assay system is based on the immunocapture of low numbers of oocysts, which can be heat shocked to induce the production of a specific mRNA, which in turn can be amplified by NASBA and detected in an easy-to-perform and interpret manner. The entire assay can be completed in less than 4 hours, is less complicated to perform than current methods, and can distinguish nonviable oocysts. Furthermore, the improved assay system will reduce the number of false positive determinations caused by misreading of immunofluorescence slides. Phase II efforts will focus on transforming the above laboratory findings into a commercial product with applications in the drinking water industry. Those efforts will (1) finalize the detection limit of the test, (2) compare current viability/infectivity assays against results of the CryptoDetect(tm) Test System, (3) determine the effect of contaminants that might be found in raw water samples and whether changes need to be made to overcome any such effects, (4) further simplify the test methods required, and (5) evaluate the CryptoDetect(tm) Test System in head-to-head comparison against Method 1622 using and independent Verification Testing Organization (VTO) approved by U.S. EPA. Information contained within the "Technology Niche Assessment" completed by Foresight Technologies on behalf of EPA will continue to be used to attract a commercial partner to manufacture and market the product to the drinking water industry.

Low-Cost Instrument for Long-Term Monitoring of Hazardous Contaminants in Drinking Water (EPA 2007 SBIR Phase 1)
Investigator: John Chetley Ford, 617-668-6801, cford@rmdinc.com
Company: Radiation Monitoring Devices Inc., Watertown, MA.
Contract: EPD07040
Project Period: March 1, 2007 through August 31, 2007
Project Amount: $70,000

Radiation Monitoring Devices, Inc. (RMD) proposes to design and build a miniature, permanent, magnet-based nuclear magnetic resonance (NMR) spectrometer that can be lowered into drinking water systems. NMR utilizes the same technologies as those used to scan the human body in clinical magnetic resonance imaging machines and uses no harmful radiation. NMR proton spectra will provide continuous, precise, and specific monitoring of the water concentration of substances, such as pesticides, toxic industrial chemicals, chemical warfare agents, and bioaccumulative metal-based and organic toxins, such as mercury and polychlorinated biphenyls. NMR signal sensitivity will be enhanced several orders of magnitude by using nano-scale solid-state sensors rather than conventional wire radiofrequency coils. A major advantage of the technical approach is that because it is NMR-based, any number of chemical compounds can be monitored simultaneously without modification to the hardware or software. Several of these low-cost systems, wirelessly connected to a central computer, can be deployed at various strategic sites within a drinking water facility. Time-sequenced maps of contaminant concentrations, overlaid on a facility map, can pinpoint the source of contaminant release, affording timely information to alert emergency response personnel. During Phase I, RMD will design and build a bench-top NMR spectrometer that will serve as a test bed to develop innovative solid-state sensors that provide extraordinary sensitivity. The outcome of Phase I will be an optimized NMR sensor as well as the most advantageous NMR data collection parameters for measuring trace contaminants in water. The knowledge gained from the Phase I effort will lead to a Phase II prototype capable of unprecedented capabilities in long-term monitoring of drinking water contaminants at very low cost. The Phase II prototype would find many applications within the commercial sector, such as in the petroleum industry for oil well logging and for monitoring contaminants in storage facilities. It also could be utilized to monitor groundwater in or around manufacturing facilities. The instrument would find numerous screening and monitoring applications within the agricultural sector and food industry.

Automated Sample Collection and Concentration System for Multiple Pathogens in Water (EPA 2007 SBIR Phase 2)
Investigator: Fu-Chih Hsu, 574-277-4078, fuchih@scientificmethods.com
Company: Scientific Methods, Inc., Granger, IN.
Contract: EPD07089
Project Period: May 1, 2007 through April 30, 2009
Project Amount: $224,998

The goal of this research project is to develop a simple, rapid, and highly automated sample collection system that will concentrate a broad range of pathogens simultaneously. The system will integrate continuous flow centrifugation (CFC) with an innovative positively charged filter so that large (i.e., protozoan parasites and bacteria) and small (i.e., enteric viruses) bioparticles can be concentrated under an integrated platform. Because CFC is not subject to the limitations of traditional filtration approaches that are subject to fouling, and because its utility was evaluated extensively through Phase I study using a broad range of waterborne pathogens, the integration of CFC and cartridge filtration will extend the utility of the sample concentration platform to accommodate a diverse range of natural and treated water samples that cannot be processed using current filtration methods alone. The system developed in this research project is intended to be compatible with current and commonly employed analytic detection techniques and other advanced detection methods, such as real-time PCR, DNA microchip arrays, and other biosensors. This innovative sample collection and concentration system will provide concentrated samples for routine and advanced water quality monitoring, and will be readily incorporated as a front-end measure for rapid identification of bio-agents in the face of bioterrorism events and post-attack monitoring. The final product is envisioned as an automated sample collection and concentration device that will accommodate a variety of water matrices ranging from finished drinking waters to particle-rich matrices such as surface and wastewaters. The open design of the automated system also will extend the utility of on-line and real-time sensor arrays for waterborne pathogens and indicator microorganisms.

Field Test Kits for Rapid Detection of Hazardous Contaminants on Indoor Surfaces (EPA 2007 SBIR Phase 1)
Investigator: Xichun Zhou, 303-792-5615, xichunz@adatech.com
Company: ADA Technologies, Inc., Englewood, CO.
Contract: EPD07023
Project Period: March 1, 2007 through August 31, 2007
Project Amount: $70,000

ADA Technologies, Inc. proposes to develop novel test kits for the rapid collection and identification of biological and chemical hazards on indoor surfaces. The field test kits include litmus paper-like test strips, treated cotton swabs for collecting indoor surface contaminants, and a portable fluorescent reader. The proposed test strips are based on binding-induced fluorescent resonance energy transfer (FRET) detection by employing an aptamer molecular beacon specific to the hazardous agent as the recognition element and fluorescent quantum dots as signal development. The test strip combines the advantages of highly specific and stable aptamer receptors, nanotechnology, and immunochromatographic bioassays. In the Phase I feasibility demonstration, ADA will develop and evaluate prototype test strips based on the binding-induced FRET immunoassays for detection of biological simulants of anthrax spores and ricin and botulinum toxins. Based on the success of Phase I, in Phase II ADA will generate aptamers specific to other biological and chemical hazards such as smallpox, plague, and highly toxic pesticides, and develop test strip panels embedded with multiple aptamer probes in arrayed format for simultaneous detection of multiple biological and chemical hazard contaminants in a single measurement. Phase II work also will include leveraging a commercially available portable fluorescence reader in addition to testing field performance in terms of the selectivity and robustness. This proposed research will provide an improved understanding of the use of aptamers as a specific receptor for the detection of a wide range of chemical and biological toxins. The results of this research will lead to rapid, cost-effective, fieldable test kits with prolonged storage life and low rates of false positive/false negative response. The test kit technology also can be adapted to construct tests for many other important substances, such as drugs, toxins, and heavy metals.

### Fiber Optic Sensors With Hydrophilic, Radionuclide-Selective Cladding for the Detection of Radionuclides in Water Supplies (EPA 2007 SBIR Phase 1)

Investigator: Andrea E. Hoyt-Haight, 505-346-1685, adherenttech@earthlink.net
Company: Adherent Technologies Inc., Albuquerque, NM.
Contract: EPD07024
Project Period: March 1, 2007 through August 31, 2007
Project Amount: $70,000

In this proposed Phase I project, Adherent Technologies will develop a fiber-optic scintillator system with radionuclide-selective cladding for use in the detection of radionuclide contamination in water supplies or wastewater streams. The major advantage of this technology relative to current off-site laboratory methods of detecting radionuclides in water systems is "instant" on-site detection, which would allow for an appropriate and timely emergency response. Monitoring of radiological threats to water supplies is similar to the problem of monitoring groundwater contamination at DOE facilities around the country. Significant challenges include the development of a robust detection system that can be used in a continuous monitoring mode and will be sensitive to extremely low levels of contamination. The selective scintillating fiber-optic devices to be developed during this project are expected to be capable of real-time or on-demand analysis and also are amenable to long-term and/or remote monitoring scenarios. When a large volume of scintillator is employed (either as a single-fiber sensor or in sensor bundles), these systems also should be capable of providing detection levels corresponding to drinking water standards. In addition, the use of chemically selective preconcentrating layers is expected to improve further the sensitivity and detection limits of the proposed sensor platform. Desirable attributes of these fiber optic devices include small size, light weight, low cost, low power consumption, and easy integration into a wide variety of application environments. These devices would represent a significant improvement over the current baseline methods that are based on costly laboratory analysis procedures performed at centralized laboratories.

Wireless Electrochemical ClO2 Monitor for Decontamination Operations (EPA 2007 SBIR Phase 1)

| | |
|---|---|
| Investigator: | Mourad Manoukian, 781-529-0500, avaccaro@ginerinc.com |
| Company: | Giner, Inc., Waltham, MA. |
| Contract: | EPD07029 |
| Project Period: | March 1, 2007 through August 31, 2007 |
| Project Amount: | $70,000 |

U.S. EPA has identified the need for an accurate and field-rugged instrument to monitor chlorine dioxide ($ClO_2$) for use in monitoring building decontamination operations. The proposed Phase I study will evaluate the feasibility of designing and fabricating an advanced electrochemical $ClO_2$ sensor utilizing integrated solid polymer electrolyte proton-conducting membrane, as well as thick and thin film electrode structure technology, and demonstrating its successful operation with wireless data transmission. The sensor will be designed for accurate and rapid (less than 30 seconds for 90% of full response, T90) detection of $ClO_2$ concentrations in the range of 0 to 3,000 ppm with a detection limit of 2 ppb. One of the aims of the Phase I project is the evaluation of specificity of the proposed sensor to $ClO_2$ mixtures at the relevant levels in the presence of potentially interfering compounds. The proposed sensor will be configured for continuous unattended or hand-held operation. In Phase II, the advanced electrochemical sensor will be fully integrated with wireless data transmission and configured into a compact and lightweight monitor that will allow for independent operation of the monitor, complete with calibration routine and digital display of numeric results. An accurate, portable, and reliable $ClO_2$ monitoring device capable of wireless data transmission could find a broad commercial use. The proposed hand-held and inexpensive (< $100 to manufacture in quantities greater than 10,000 units) electrochemical $ClO_2$ monitor that is capable of monitoring $ClO_2$ levels in real-time with a detection limit of 2 ppb could be used for applications intended to control microbiological growth in industries such as dairy, beverage, pulp and paper, fruit and vegetable, poultry, beef processing, and miscellaneous food processing applications.

Microbial Community Microarrays to Assess Chemical and Biological Characteristics of Water Quality (EPA 2007 SBIR Phase 1)

| | |
|---|---|
| Investigator: | Michael Marshall, 919-572-6581, klevert@setechinv.com |
| Company: | Southeast TechInventures, Inc., Research Triangle Park, NC. |
| Contract: | EPD07041 |
| Project Period: | March 1, 2007 through August 31, 2007 |
| Project Amount: | $69,904 |

This Phase I SBIR project intends to demonstrate the feasibility of a freshwater microbial community microarray, called the WaterChip™, for detecting the presence of an important model for a mercury chemical pollutant in freshwater. By demonstrating its utility for detecting evidence of this pollutant, the basis for expanding the WaterChip's™ capability to other environmental toxins and pollutants will be undertaken in Phase II. The ultimate goal of the proposed work is to develop a tool that provides comprehensive, economic, and rapid evaluation of water quality. The proposed WaterChip™ technology is based on detecting individual DNA fingerprints derived from environmental samples to indicate the presence of specific chemical and biological contaminants. This approach will offer a single, rapid, broad-spectrum environmental diagnostic platform that facilitates protection of the environment and public health. The microarray also has the potential to serve as a discovery tool for environmental microbes that are useful for bioremediation. The water-test equipment and service market is a multi-billion dollar industry with a 5-7% steady growth rate. The ultimate goal is to develop a unique water quality test that can be used as a laboratory tool and in remote, real-time monitoring systems. The test platform can reduce the fixed costs of equipment and laboratory training, providing economies of scale for routine testing of water supplies.

Development of a Reliable, Low-Cost and User-Friendly Spot Test Kit for Leaded Paint and Dust Based on Recent Advances in Bionanotechnology (EPA 2007 SBIR Phase 2)

| | |
|---|---|
| Investigator: | Juewen Liu, jliu2@uiuc.edu |
| Company: | DzymeTech, Inc., Champaign, IL. |
| Contract: | EPD07081 |
| Project Period: | May 1, 2007 through April 30, 2009 |
| Project Amount: | $225,000 |

On-site and real-time detection and quantification of lead in paint/dust are very important to homeowners and certified lead-based paint removal professionals. DzymeTech, Inc., proposes to develop a reliable spot test kit based on patented and patent-pending technologies developed by Dr. Yi Lu's group at the University of Illinois, Urbana-Champaign. The technology employs catalytic DNA for lead detection. Under SBIR Phase I funding from EPA, DzymeTech has demonstrated the feasibility of using the catalytic DNA-based detection approach for lead in dust in terms of sensitivity, selectivity, interference, precision, stability, and long-term storage. In Phase II, we propose to build and test a prototype of the lead sensor. The prototype kit will contain all the sensor reagent and components with minimal manual transfer of solution needed. The prototype kit will be characterized in terms of sensitivity, selectivity and stability, and will be tested by different users (including EPA inspectors and home-owners) for field sample assays. To achieve the objective of developing a reliable, low-cost, and user-friendly spot test kit, DzymeTech will investigate methods for efficient dust sample collection, lead extraction, and applications of the colorimetric lead sensors under different conditions. Both simulated and real lead dust samples will be used for the test kit evaluation. Factors that improve the user friendliness, shelf life, and cost effectiveness of the test kit will be evaluated.

A Low-Cost Chemosensor for Measuring Phosphate in Water and Soil (EPA 2007 SBIR Phase 1)

| | |
|---|---|
| Investigator: | Thomas E. Coleman, 509-454-5094, tecoleman@dtecsystems.us |
| Company: | dTEC Systems LLC, Seattle, WA. |
| Contract: | EPD07048 |
| Project Period: | March 1, 2007 through August 31, 2007 |
| Project Amount: | $70,000 |

The proposed Phase I SBIR project is expected to lead to the development of a low-cost portable instrument capable of making real-time measurements of phosphate in water and soil samples. The sensor system for this instrument will be based on the highly selective phosphate binding properties of a co-polymer to be synthesized in this research. When phosphorus is released into water bodies with adequate nitrogen available, eutrophication is likely to result. Eutrophication has been identified as the main cause of impaired surface water quality in the United States. Concentrations of phosphate in solution are usually small, and time is often a critical factor in taking measurements because the inorganic phosphate in a water sample is changing as a result of biological processes. Because of these factors, there is a need for sensitive, inexpensive, and portable instruments to monitor the eutrophication process effectively. Currently available instruments for making phosphate measurements in the field do not adequately address these needs. The sensor to be developed in Phase I will be based on a commercially available microfabricated fringing electric field (FEF) substrate coated with a phosphate-binding polymer. The substrate electrode periodicity will be in the low microns range. By incorporating nanofabrication techniques in the Phase II portion of this research, it will be possible to design and fabricate smaller electrode structures, allowing enhancement of the sensitivity of the sensor system by tuning the electric field pattern generated by the FEF sensor to the dimensions of the proposed phosphate-binding polymer coatings. The key result needed to support the development of a prototype instrument will be the demonstration of binding selectivity for phosphate. A chemosensor developed on the basis of this selectivity would be relatively inexpensive, would require no chemical reagents, and could easily be installed in the field for continuous and/or remote monitoring applications. Additional commercial opportunities are possible for wastewater treatment process control and other environmental monitoring applications.

Graded Interference Filter Spectrometer (EPA 2007 SBIR Phase 1)

| | |
|---|---|
| Investigator: | Joseph Cosgrove, 860-528-9806, cosgrove@AFRinc.com |
| Company: | Advanced Fuel Research Inc., East Hartford, CT. |
| Contract: | EPD07025 |
| Project Period: | March 1, 2007 through August 31, 2007 |
| Project Amount: | $69,976 |

The release of volatile organic compounds (VOCs) from industrial processes can have negative impacts on the environment while also posing significant health and safety concerns. Although chemical recovery and waste treatment strategies are employed to reduce the emissions of VOCs, there is a strong need for a low-cost, compact sensor that can quickly and reliably identify leaks in the facility process line. Infrared spectroscopy is an excellent method for the analysis of VOCs; however, infrared spectrometers are complex instruments that are too expensive and physically bulky for leak detection applications where low cost, portability, and maneuverability are critical. Advanced Fuel Research, Inc. proposes to develop a low-cost, very compact infrared spectrometer based on a novel graded interference filter, in combination with an infrared microbolometer focal plane array detector. Phase I will fabricate the graded interference filter. A prototype spectrometer then will be assembled with the filter coupled to a microbolometer focal plane array. Gas-phase measurements will demonstrate the spectral accuracy and resolution of the instrument. Phase II will result in a complete infrared spectral sensor covering the mid- and long-wavelength infrared regions, including the analysis algorithms and light-gathering optics for remote chemical sensing. In addition to applications as a remote VOC leak detector, the technology developed in this program will have applications for gas sensing in process monitoring and control and in continuous emissions monitoring.

### Feasibility of Monitoring Heavy Metal Emissions From a Coal-Fired Thermal Hazardous Waste Incinerator Using a Multi-Metal Continuous Emissions Monitor (EPA 2007 SBIR Phase 1)

Investigator: John A. Cooper, 503-624-5750, jacooper@cooperenvironmental.com
Company: Cooper Environmental Services, LLC, Portland, OR
Contract: EPD07026
Project Period: March 1, 2007 through August 31, 2007
Project Amount: $69,949

Under the current Hazardous Waste Combustor Maximum Achievable Control Technology rule, heavy metal emissions from the nation's thermal hazardous waste combustion facilities are estimated using control efficiencies determined during performance testing and estimated metal feed rates during normal operation. The error in estimates of metal emissions from this approach can be on the order of 100% or more. This error could be greatly reduced by measuring emissions continuously using a multi-metal continuous emission monitor (CEM). Cooper Environmental Services, LLC has developed a multi-metal CEM, the Xact, which recently has been accepted by U.S. EPA for compliance purposes on a gas-fired thermal hazardous waste incinerator. The stack effluent from this facility, however, does not represent a particularly challenging environment. The particulate matter (PM) levels, the moisture content, and the SOx and NOx levels are all low relative to other types of facilities. The research described for this project will demonstrate the feasibility of using the Xact on a coal-fired thermal hazardous waste incinerator. The proposed EPA coal-fired test facility would have higher levels of PM, SOx, and NOx, higher moisture content, and higher temperatures, thus representing a more challenging environment for Xact operation. Procedures used for feasibility demonstration will be similar to those used for EPA Method 301 validation of the Xact on the gas-fired incinerator. These procedures will test the Xact for accuracy and for the linearity of its response to a dynamically spiked metal concentration. If successful, this feasibility study could pave the way for the Xact to be used on coal-fired thermal hazardous waste sources, as well as other coal-fired sources with regulated metal emissions, including municipal waste incinerators, coal-fired power plants, and industrial furnaces and boilers.

### Nanoparticle-Based Lateral Flow Microarray Test Strip Assay (EPA 2007 SBIR Phase 1)

Investigator: Srivatsa Venkatasubbarao, 310-530-7130, sbirproposals@intopsys.com
Company: Intelligent Optical Systems Inc., Torrance, CA.
Contract: EPD07031
Project Period: March 1, 2007 through August 31, 2007
Project Amount: $70,000

Nanoparticles exhibit unique optical properties that can be exploited in the development of highly sensitive assay systems. This project describes the development of a lateral flow test strip microarray that will utilize nanoparticle amplification to detect waterborne pathogens. Waterborne pathogens have been chosen for this study because they can cause severe illness, and even death, and therefore the identification of these pathogens in water is critical. The proposed system will be field-usable, easy to operate, and inexpensive. Furthermore, it will have very high sensitivity and multiplex capabilities to allow detection of several different pathogens simultaneously in a single assay. In the proposed Phase I project, the lateral flow test strip microarrays will incorporate the nanoparticle amplification strategy, and a sensitive and inexpensive hand-held reader will be fabricated. The Phase I feasibility will be demonstrated by simultaneously testing three different pathogens in a water sample. We will demonstrate the ability of this technology to meet or exceed the performance of laboratory-based ELISA test kits. We also will describe the path that will lead to truly multiplexed assays in Phase II and beyond. The successful completion of this project will result in an indispensable tool to be used in water treatment facilities. It also will be beneficial in food testing and medical applications. Beyond these civilian uses, the proposed technology will be useful for detecting pathogens in military environments.

### Field Rugged, Portable H2O2 Monitor (EPA 2007 SBIR Phase 2)

Investigator: Michael (Mickey) B. Frish, 978-689-0003, contact@psicorp.com
Company: Physical Sciences, Inc., Andover, MA
Contract: EPD07087
Project Period: May 1, 2007 through April 30, 2009
Project Amount: $224,966

This Phase II SBIR project will develop a field-portable instrument for monitoring and controlling hydrogen peroxide ($H_2O_2$) concentration during building decontamination after accidental or purposeful exposure to hazardous biological materials. This product will enable accurate real-time $H_2O_2$ measurements over the concentration range of 1-10,000 ppmV. The product is an adaptation of a portable gas-sensing platform based on tunable diode laser absorption spectroscopy (TDLAS) technology. The sensor will offer a combination of sensitivity, specificity, fast response, dynamic range, linearity, ease of operation and calibration, ruggedness, and portability not available in alternative $H_2O_2$ detectors. Compared to other spectroscopic gas analyzers, TDLAS offers the benefit of probing individual spectral lines, rather than spectral bands. This capability enables $H_2O_2$ to be distinguished from water, thus overcoming a cross-sensitivity that has limited the accuracy of other $H_2O_2$ analyzers. In Phase I, Physical Sciences, Inc. (PSI) acquired the data needed to select the best $H_2O_2$ spectral features for these measurements, thereby establishing the feasibility of developing the novel $H_2O_2$ sensor. In Phase II, PSI, working with industrial collaborators, will specify the requirements of a field-worthy sensor, build a prototype, calibrate it, test it in realistic deployment scenarios, and verify that the sensor meets its performance specifications. In the Phase II Commercialization Option, PSI will build and calibrate a TDLAS system that measure both $H_2O_2$ and $H_2O_2$ vapors. The initial application for the $H_2O_2$ sensor will be for building decontamination applications. Customers for this product include government agencies (e.g., EPA) and their contractors. Commercial uses of the product include pharmaceutical manufacturing and other sterilization applications.

### Balloon Platforms for Remote Sensing of Water in Mixing Zones (EPA 2007 SBIR Phase 2)

Investigator: Robert L. Doneker, 503-222-1022, doneker@mixzon.com
Company: MixZon, Inc., Portland, OR
Contract: EPD07086
Project Period: May 1, 2007 through April 30, 2009
Project Amount: $224,978

MixZon hypothesizes that infrared (IR) cameras mounted on unmanned tethered helium balloons accessed via a wireless network can remotely sense water quality in mixing zones at site scales. Mixing zones are limited regions in water bodies where the initial dilution of point-source wastewater discharge occurs. Mixing zones are an important component of the NPDES permitting process within total maximum daily load (TMDL) water quality management programs. In Phase I, MixZon developed a low-cost, rapidly deployable, aerial remote sensing system for monitoring water quality in riverine mixing zones. The patent-pending platform monitors outfall performance and focuses on temperature as a dilution tracer. In cooperation with EPA Region 10 and Oregon Department of Environmental Quality, MixZon successfully field-demonstrated the system at an industrial discharge site. MixZon proved the technical feasibility of the remote sensing concept to gather continuous, real-time, site-scale, geo-reference mixing zone data for NPDES regulatory compliance and ESA habitat assessment. Alternative aerial remote sensing platforms have limited availability, high costs, and long lead times to schedule deployment. The cost of the platform will be one-third to one-tenth of competing technology. The platform can be deployed by 2 to 3 people with minimal operator training and is suitable for monitoring at fixed locations for longer time periods than is practical for alternative airborne sensors. In Phase II, MixZon will continue to focus on mixing zones in rivers, where vertical mixing of point sources discharges is rapid but may exhibit long downstream distances for full lateral mixing. MixZon will develop technology to better aim and control the sensors and to identify temperature differentials and associated wastewater types (e.g., process cooling waters, municipal effluents, pulp mill effluents, etc.), outfall configurations (e.g., surface shoreline, submerged single port, multiport diffuser), and ambient conditions that lead to successful monitoring. MixZon will develop tools for hydrodynamic mixing zone model validation and calibrations, commercialize the platform by demonstrating deployment with industrial sponsors, and work with EPA partners on technology verification. Although the platform detects temperature as a water quality parameter, the potential to model the fate and transport of other discharge constituents may be much more widespread (e.g., shoreline recreational exposure to pathogens from wastewater discharges, determination of spatial extent of contaminated sediment deposits from mining operations, detecting the impacts of contaminated groundwater interactions within in groundwater/surface recharge zones, and analysis of thermal refugia habitat for endangered species management).