NINTH MEASUREMENT AND MONITORING LITERATURE UPDATE

Advanced Tensiometer for Vadose Zone Monitoring. Innovative Technology Summary Report
U.S. DOE, Office of Science and Technology. Characterization, Monitoring, and Sensor Technology Crosscutting Program and Subsurface Contaminants Focus Area.
Report No: DOE/EM-0639, 42 pp, Sep 2002

The Advanced Tensiometer for Vadose Zone Monitoring (referred to hereafter as the Advanced Tensiometer, or AT) was developed to overcome the limitations of conventional tensiometers. ATs are superior to conventional tensiometers primarily because they provide reliable soil water potential measurements at much greater depths than conventional tensiometers, require less frequent maintenance than conventional tensiometers, and are largely unaffected by ambient temperature changes, whereas conventional tensiometers are adversely affected. The AT operates on the same physical principle as a conventional tensiometer. It has two parts: a permanently installed porous cup with a water reservoir and guide tube and a removable pressure transducer. The AT is deployed by lowering it into a borehole and bringing the porous cup into good hydraulic contact with the subsurface soil. Water in the reservoir then moves through the porous cup until the pressure inside the reservoir equilibrates with the soil moisture pressure in the surrounding soil or rock. The pressure transducer measures the partial vacuum; a data logger at the surface records the measurements. The AT developed at the Idaho National Engineering and Environmental Laboratory (INEEL) is a 1997 R&D-100 award winner (R&D Magazine 1997). The AT features a short water column that is isolated from diurnal temperature changes. This stabilizes the readings compared to those from conventional tensiometers. The AT is an effective instrument for monitoring when the soil water potential is in the range 0 to -800 cm water pressure. This is the energy status range with the highest hydraulic activity, and thus with the greatest potential for rapid water movement. The AT design is simple, low cost, and low maintenance. There are no moving parts and the pressure transducer is serviceable from the land surface. The AT is a dual-purpose instrument. It is used primarily to monitor soil water potential, but it can also be converted readily for the collection of soil water samples. North Wind Environmental, Inc., of Idaho Falls, ID, entered into an exclusive license agreement regarding the manufacture and sale of all products covered by the claims of U.S. Patent No. 5,915,476, including the AT and PT, in November 2000. The initial license covers application at the INEEL site only, but it can be extended for applications at other federal sites upon request. North Wind operates on a contract basis, providing geosciences consulting and subsurface characterization services. North Wind has constructed and installed ATs and is available to reduce and analyze tensiometer data. For patent and licensing information, contact: Gary Smith, Idaho National Engineering and Environmental Lab, (208) 526-3780, smitgw@inel.gov.
http://apps.em.doe.gov/OST/itsrall.asp

Aerosol Hazard Characterization and Early Warning Network
Wyatt, Philip J. (Inventor); Assignee: Wyatt Technology Corporation, Santa Barbara, CA.
United States Patent No 6,490,530, 3 Dec 2002

An aerosol hazard classification and early warning network is composed of a large number of detector and analysis units, called "detector stations," which are deployed throughout a region to be warned of a potentially hazardous aerosol intrusion. Such aerosol threats may originate from fires, volcanic eruptions, or overt releases of biological and chemical agents dispersed in aerosol form. Among the former are the characteristic toxic aerosols released during refinery fires or explosions. The latter biological agents include bacterial spores, lyophilized bacterial cells, and virus preparations, whereas chemical agents might include various forms of nerve gasses and other anti-personnel gasses such as mustard, all commonly deployed in aerosol form. Each detector station contains an aerosol handling unit that samples and transfers ambient aerosol particles one-at-a-time through a light scattering

chamber where each such particle is constrained to pass through a fine laser beam producing, thereby, an outgoing scattered light wave. The scattering chamber contains a plurality of scattered light detectors arranged to accept light scattered into different angular locations. The signals detected at each detector position are processed by a corresponding digital signal processing chip with the resulting set of digitized signals being transferred to an on-board central processing unit. The CPU analyzes the set of light scattering signals and identifies or otherwise characterizes each particle. The classification/identification data are then stored and, on preprogrammed command, telemetered to a remote "central station" by means of an on-board telemetry unit. The central station analyzes the sets of data received from all the detector stations and then instructs, as necessary, selected detector stations via telemetric means to change their sampling and telemetry rates. As soon as sufficient data are available, the central determines the presence, threat, extent, and progress of the aerosol cloud. These factors are then telemetrically transmitted by means of alarms and warnings sent to potentially threatened regions.

Application Note: Simplifying Cyanide Analysis with Microdistillation
Volmer, Wolfgang (Eppendorf-Netheler-Hinz GmbH, Hamburg, Germany); Günter Giesselmann.
American Laboratory News, p 18-22, Jan 2000

Cyanide determination tests conducted with the ion chromatograph BTIC 1000 (Eppendorf Biotronik, Hamburg, Germany) demonstrate the possibility of minimizing cyanide determination without any adverse effect on the accuracy of the process. Tests carried out using the MicroDistiller require less space, sample material, reagent, and cleaning. Photometric determination with 1,3-dimethyl barbituric acid/pyridine-4-carbonic acid prevents the user from having to deal with pyridine. The citrate-phosphoric acid mixture enables complex iron cyanide to be decomposed quantitatively without requiring the addition of copper/zinc salts. No modifications are required for the determination of total cyanide according to the U.S. EPA method description, though the photometric determination after the microdistillation has to be performed with barbituric acid/pyridine instead of 1,3-dimethyl barbituric acid/pyridine-4-carbonic acid. The determination of free cyanide according to German standard method DIN 38405 is also possible by means of a small gas manifold (GasController) that can be attached to the rear of the instrument. Free cyanide is separated from the sample in the form of hydrocyanic acid with the aid of a supply of air at room temperature and a pH value of 4. The hydrocyanic acid is absorbed in sodium hydroxide solution and then photometrically determined following reaction with 1,3-dimethyl barbituric acid/pyridine-4-carbonic acid.
http://www.iscpubs.com/articles/aln/n0001vol.pdf

Artificial Neural Network Tools for the Analysis of Microbial Biomarker Data
Brandt, C.C., PI (ORNL, Oak Ridge, TN), J.C. Schryver (ORNL, Oak Ridge, TN); J.S. Almeida (Medical Univ. of South Carolina, Charleston); S.M. Pfiffner (Univ. of Tennessee, Knoxville); A.V. Palumbo (ORNL, Oak Ridge, TN).
DOE-NABIR PI Workshop, 18-20 March 2002, Warrenton, Virginia.
Natural and Accelerated Bioremediation Research Program (NABIR). p 24, 2002

Artificial neural network (ANN) tools are being developed for relating changes in microbial biomarkers to the concentration of heavy metals and radionuclides. ANNs are nonlinear pattern-recognition methods that can learn from experience to improve their performance. The researchers have successfully applied these techniques to the analysis of membrane lipids and nucleic acid biomarker data from both laboratory and field studies. This presentation summarizes the results of analyses, outlines some refinements to standard ANN methods that help with the analysis of small-sample-size data sets, and outlines the Web-based tool kit being developed for use by other NABIR investigators.

Chemical and Biological Sensors for Environmental Monitoring: Biosensors
Mulchandani, Ashok (Univ. of California, Riverside); Omowunmi A. Sadik (SUNY at Binghamton) (eds).
Oxford University Press, New York. American Chemical Society (ACS) Symposium Series 762, ISBN: 0-8412-3687-9. 352 pp, 2000

This volume describes the most recent advances in the design, research, development, and application of environmental chemical sensors and biosensors. Topics encompass the rational assembly of dynamic macromolecules, biocomponent stability, DNA-based biosensors, molecular beacons, an electronic nose, multianalyte-transducers, sensor systems, and others as tools for environmental monitoring. It provides perspective on how recent works in chemical and biological sensors are meeting the challenges of environmental monitoring through enhanced specificity, fast response times, and the ability to determine multiple analytes with little or no need for sample preparation steps in complex samples.

Cone Permeameter™. Innovative Technology Summary Report
U.S. DOE, Office of Science and Technology. Characterization, Monitoring, and Sensor Technology Crosscutting Program and Subsurface Contaminants Focus Area.
Report No: DOE/EM-0632, 28 pp, Sep 2002

The Cone Permeameter™ is a sensor designed to be deployed using a cone penetrometer. The sensor measures air permeability and saturated hydraulic conductivity of soils at discrete intervals in the subsurface. These measurements allow the prediction of how ground water and air will move through the subsurface. Determining the permeability of soil and sediment is essential for predicting the migration paths of contaminants and for designing optimal remediation strategies. In most cases where the contamination has moved into the subsurface, remedial treatment requires removal of ground water for surface treatment, circulation of ground water through a treatment cell, or circulation of treatment fluids or gases. Adetailed knowledge of the permeability distribution in the subsurface can help support ground-water modeling efforts and lead to more efficient design of remedial systems. The Cone Permeameter™ was developed by Science and Engineering Associates (SEA) under funding from the DOE National Energy Technology Center. Geoprobe Systems, Inc., has licensed the Cone Permeameter™ patent from SEA and began manufacturing and distributing the systems through their marketing network in 2001. The system will be available for use by DOE contractors and environmental firms, including SEA, for field application. Costs for characterization of the permeability distribution at a typical site to support ground-water modeling and remedial design efforts should be reduced by 60-75% over baseline hydraulic testing. The use of the Cone Permeameter™ minimizes or eliminates secondary waste from the installation of the monitoring wells and more significantly from ground water that must be collected and treated during baseline hydraulic testing. The Cone Permeameter™ has been demonstrated and/or deployed at four waste sites within the federal government complex: the D-Area Coal Pile, Savannah River Site; the Old Burial Ground, Savannah River Site; Launch Complex 34, Cape Canaveral Air Station; and the 200 East Area at Hanford. The potential market for the Cone Permeameter™ is sizable because the technology is an inexpensive system that measures a key parameter needed in ground-water modeling and in support of design and optimization of the remedial systems at large or complex waste sites. Contacts: Bill Lowry, Science and Engineering Associates, Inc., (505) 424-6955, blowry@seabase.com; Carol Eddy-Dilek, Westinghouse Savannah River Company, (803) 725-2418, carol.eddy-dilek@srs.gov; or Tom Christy, Geoprobe Systems, Inc., (800) 436-7762, christyt@geoprobesystems.com. For the full text of the report, visit http://apps.em.doe.gov/OST/pubs/itsrs/itsr307.pdf

Cost and Performance Report: Field Validation of Real Time Airborne Lead Analyzer

Naval Facilities Engineering Service Center, Port Hueneme, CA.
Report No: NFESC-TR-2198-ENV, NTIS: ADA400420, 38 pp, Jan 2002

The objective of this project was to demonstrate and validate a personal breathing zone (PBZ) lead analyzer/single sample ambient air monitor (AAM) that will report occupational airborne lead levels in near real time. The analyzer was first field-tested at the indoor firing range located at Naval Amphibious Base Little Creek, VA, in January 2000. Based on the field results, further work was conducted on the unit before going to the second demonstration location, an outdoor firing range at MCAGCC Twentynine Palms, CA, in June 2000. Both facilities provided real-world materials created by live fire rifle and pistol shooting exercises. The AeroLead™ failed to meet all of the performance criteria during this program and therefore was not validated. Had the objective been accomplished, significant improvements to occupational safety and decreases in the cost of OSHA compliance would be realized. Current OSHA protocols require sending PBZ samples to a laboratory for analysis, resulting in delayed report times (24 hours to three days) and an increased potential for sample integrity breaches due to shipping and handling. The Naval Facilities Engineering Service Center seeks an improved method of airborne lead sampling and analysis to provide nearly instantaneous feedback.
http://handle.dtic.mil/100.2/ADA400420

Critical Comparison of Cyanide Measuring Methods
Raisz, Ivan (fkmraisz@silver.uni-miskolc.hu); Peter Raisz, Janos Emmer, Univ. of Miskolc, Hungary.
Kemometria '01: Hungarian Chemometric Workshop, 3-5 October 2001, Pécs, Hungary

In the spring of 2000, one of the largest cyanide contamination events of all time (95 tons) flowed down the rivers Tisza and Danube. The contamination originated from a non-EU-compatible flow of sewage and hazardous wastes from a barrow of cyanide gold extraction in Rumania. Researchers statistically evaluated the time series of cyanide data from five cross-sections of the Upper Tisza. The data were measured via laboratory and test paper measurements to determine the amount of contamination. The incident highlighted the need for an early warning monitoring system and the continuous follow-up of any accidentally occurring new contamination, preferably a reliable online system. Contaminant measuring stations require the flexibility to move with a wave of contamination, while providing continuous information, and the measurements must be performed in a reliable way under extreme weather conditions, including measurements under firm ice and water temperatures above 250°C, which means great emphasis is laid on weather resistance. To begin the fulfillment of this need, the authors compiled a critical analysis of publications of the last decade on cyanide determination. The analysis sought methods for determining all forms of cyanides, since released cyanide may be bound in complex forms. They investigated the perturbing effect of the heavy metals accompanying the cyanides in different quantities. The performance characteristics of each method were investigated for selectivity, recovery range, linearity, limit of detection, limit of determination, ruggedness, and precision.

Cyanide Detection in Water by Photosynthetic Tissue-Based Biosensors
Rodriguez, Miguel, Jr.; Elias Greenbaum, Oak Ridge National Laboratory, Oak Ridge, TN.
Highlights of Recent Research, Oak Ridge National Laboratory (ORNL), Jun 2002

DARPA is funding research into the detection of low levels of cyanide in water by in situ microalgal tissue-based biosensors. Directly-drawn Clinch River water samples have been analyzed with progressive concentrations (2 mM, 5 mM and 10 mM) of potassium cyanide (KCN). The Clinch is the primary source of drinking water for the City of Oak Ridge, Tennessee. Dose-response experiments were also conducted with axenic laboratory cultures of the unicellular green alga *Chlamydomonas reinhardtii*. For these KCN dose-response relationships, the photochemical yields were plotted as a function of time as well as concentration. This DARPA-funded project is led by Eli Greenbaum

(greenbaum@ornl.gov) of ORNL CSD, with technical assistance by Miguel Rodriguez, Jr. of ORNL LSD.
http://lsd.ornl.gov/highlights/rodriquez.pdf

Determination of Cyanide by a FIA-Atomic Absorption Spectrometric Method
Lopez Gomez, A.V.; J. Martinez Calatayud, Univ. of Valencia.
The Analyst, Vol 123, p 2103-2107, 1998

The authors propose a new FIA procedure for the indirect atomic absorption determination of cyanide. The FIA manifold is based on the insertion of the sample into a distilled water carrier; then the sample flows through a solid-phase reactor filled with silver iodide entrapped in polimeric resin beads. The method is simple, quick, and more selective than other published FIA procedures. Reproducibility obtained by using different solid-phase reactors and solutions is over the range 2.2 to 3.1 (as % rsd). The method has been applied to cyanide determination in commercial samples like pharmaceutical formulations and industrial electrolitic baths.

Determination of Cyanide Species in Silver and Gold Plating Solutions by Raman Spectroscopy
Cho, Keunchang; Yong Soon Jang; Myoung-seon Gong; Kwan Kim; Sang-Woo Joo.
Applied Spectroscopy, Vol 56 No 9, p 1147-1151, 2002

Raman spectra of silver and gold cyanide complexes have been investigated to determine the speciation of aqueous plating solutions. The researchers examined the ionic species in the concentration ranges of 0.003-0.5M for the metals and 0.1-2.5M for the cyanide ion. Concentrations of the metal cyanide complexes and CN 2 ion as low as 0.001-0.01M could be determined with an error of less than ~3% from the analysis of Raman peak areas.
http://chem1.snu.ac.kr/~lii/publications.html

Determination of PAH in Soil Samples by High-Performance Thin-Layer Chromatography (HPTLC)
Reimers, C. (Technical Univ. of Hamburg-Harburg, Dept. of Waste Management, Hamburg, Germany), B. Zielonka, R. Stegmann; H. Steinhart (Univ. of Hamburg, Inst. of Biochemistry and Food Chemistry, Hamburg, Germany).
Journal of Soils and Sediments, Vol 1 No 3, p 159-163, 2001 [NTIS: DE20304161]

This paper presents a thin-layer chromatographic screening method for the quick determination of polycyclic aromatic hydrocarbons (PAHs) in soil samples. The method of separation is suited for the semi-quantitative determination of PAH in soil samples, and can be used to identify samples that require further analysis by GC or HPLC. The separation of 8 PAH groups with a maximum of 2 PAHs each (discernible by selective excitation of fluorescence) is possible. The extraction of PAH is effected by means of a solvent mixture consisting of n-hexane-acetone (1:1, v/v) and aided by ultrasonic treatment. The extract is purified by application to an activated silica gel column (solid-phase extraction). The qualitative analysis can be carried out either by visual observation of the characteristic fluorescent colors or by fluorimetric scanning. The method offers user-friendly handling, low consumption of solvents, and applicability without need for extra equipment.

Development and Use of SSU rRNA Gene-Based Oligonucleotide Microarrays for Assessing Microbial Community Composition and Dynamics
Zhou, Jizhong (PI); Matthew Fields; Xichun Zhou; Dong Xu; Ying Xu; Tingfen Yan; Liyou Wu; Dorothea K. Thompson; Serguei Passovets, Oak Ridge National Laboratory, Oak Ridge, TN.

DOE-NABIR PI Workshop, 18-20 March 2002, Warrenton, Virginia.
Natural and Accelerated Bioremediation Research Program (NABIR). p 33, 2002

To understand microbial diversity of the NABIR Field Research Center (FRC), 1870 SSU rRNA clones were analyzed from ground-water samples for six different sites at the FRC that differed with respect to nitrate, organic carbon, uranium, heavy metals, and pH levels. The bacterial community structure was diverse at the background site, and representatives of at least six bacterial groups were detected, including á -, â -, ã -, ä -Proteobacteria, high G+C, and low G+C Gram-positive bacteria. Only one other site was as diverse as the background with the additional observation of *Nitrospira*, *Cytophagales/Bacteroides/Flavobacterium*, and *Acidobacter/Fibrobacter* groups. The nitrate and heavy metal levels at this site were most comparable to background, but moderate levels of uranium were detected. At a site with increased nitrate but comparable pH and heavy-metal levels, the recoverable diversity was dramatically decreased. This site appeared to be dominated by á - and â -Proteobacteria, including Rhizobium, Azoarcus, and Acidovorax species. Three sites had acidic pH values, increased uranium and nickel levels, and decreased diversity compared to background. These sites were predominated by *Azoarcus*, *Psuedomonas*, and *Ralstonia* species. The results indicated that contaminant levels impacted the bacterial community structure at the respective sites. As a part of this project, the researchers have determined whether single mismatch discrimination can be achieved with microarray hybridization for SSU rRNA genes. The results indicate that the position of the mismatch, the type of mismatch, and the concentration of hybridization additives, such as formamide and tetramethylammonium chloride (TAMCl), significantly affected discrimination power and signal intensity. The hybridization signal intensity of the probes with a single-base mismatch was about 10 to 30% of the signal intensity with the perfect-match probes, depending on the type of nucleotides. The signal intensity of the probes with two-base mismatches was about 5 to 25% compared to the perfect-match probes. Probes with three or four base-pair mismatches gave very low signal intensity, which was less than 5% of the perfect-match probes. These results indicated that single-base discrimination for SSU rRNA genes can be achieved with array-based hybridization. A new software has been developed for designing gene-specific oligonucleotide probes. For a given gene, the program automatically identifies gene-specific probes by heuristic basic local alignment search tool (BLAST) search for each gene (query) against all other genes. The optimal sequence alignment between the query and each of the homologous sequences was obtained using dynamic programming technique. Based on the alignment, the program selects gene-specific fragments. All the parameters (e.g., probe length, similarity threshold, and melting temperature) can be adjusted by the user.

Development of a Multiplexed, Bead-based Assessment Tool for Rapid Identification and Quantitation of Microorganisms in Field Samples
Lowe, Mary, PI; Rolf Halden, Physics Dept., Loyola College in Maryland, Baltimore.
DOE-NABIR PI Workshop, 18-20 March 2002, Warrenton, Virginia.
Natural and Accelerated Bioremediation Research Program (NABIR). p 29, 2002

The project is aimed at developing a quantitative, high-throughput molecular assessment tool suitable for field testing. The tool is based upon a new multiplex technology that involves hybridization of nucleic acids on the surface of microscopic, fluorescent, polystyrene beads to identify specific target sequences in complex mixtures of DNA or RNA. Following capture of target sequences obtained from environmental samples, the fluorescent beads are analyzed by flow cytometry. During the past year, the investigators have accomplished the following goals: (1) Development of a multiplex method involving a Scatchard-type model for quantifying individual sequences in polymerase chain reaction (PCR) products generated from community DNA. Experiments were conducted on 16S rRNA genes amplified from microorganisms in contaminated ground water. The findings will be published in *Applied Environmental Microbiology*. (2) Improvement of the lower detection limit by a factor of five, using novel labels known as dendrimers, with current assay refinement. (3) Development of software that

greatly speeds up the determination of the mean reporter signal for a multiplexed assay and can process raw flow cytometry data at the rate of 10 tubes (each containing, for example, a different environmental sample) in a few seconds. The bead method will be evaluated by testing a greater variety of ground-water and sediment samples than before. The current focus is on uranium-contaminated sites. A series of microcosms are currently being constructed to explore the effect of nutrient addition (e.g., ethanol, lactate, acetate) on the chemical speciation of depleted uranium. Analyses will be performed on ground-water samples already obtained from the Istok/Krumholz FRC site to determine the limits of detection and threshold densities of bacteria required for bioremediation to be effective. The suitability of ground water as a sampling matrix for detecting microbial community changes will also be explored, using samples from column and field studies.

Digestion System for Simple Cyanide Determinations
Laboratorytalk.com, Aug 2002

A decomposition and digestion instrument specifically developed to process water and soil samples for the determination of cyanide has been introduced by Gerhardt. The Cyanator, which can also be used for other determinations, enables up to four samples to be digested simultaneously, and its IR heating system provides fast and uniform heating of samples. There are two models, one automatic and the other manual. The Turbotherm Automatic is equipped with automatic control, allowing up to nine different programs to be defined, with each program having up to nine variable heating levels. The instrument displays its current status continually, with manual override possible at any time. The heating can be individually adjusted to the samples. The Turbotherm Manual is the other option, where power is set and adjusted via the energy controller. The Cyanator is easy to use and operate, and has a two-tier console for condensers and a gas flow counter located at the side, while a Steckmatic connection enables easy handling of compressed air inlet tubings. Four sample tubes can be handled simultaneously by using the insert rack. Other features include the facility to connect the instrument to existing in-house compressed air and the use of nitrogen tubing to ensure an economic and safe flow of gas. The use of inert materials is also possible. The instrument can be applied to a range of cyanide determinations including volatile cyanide, sulphide, and sulphuric dioxide.
http://www.laboratorytalk.com/news/ger/ger105.html

Down-Well Microcosm “Bug Traps” and Subsurface Sediments for Rapid Expanded-Lipid-Biomarker Analysis and DNA Recovery for Monitoring Bioremediation Microbial-Community Ecology within Samples from Uranium-Contaminated Sites
Geyer, Roland; Aaron D. Peacock; Yun-Juan Chang; Elizabeth Kline; Ying-Dong Gan; David C. White (PI), Center for Biomarker Analysis, Univ. of Tennessee, Knoxville.
DOE-NABIR PI Workshop, 18-20 March 2002, Warrenton, Virginia.
Natural and Accelerated Bioremediation Research Program (NABIR). p 32, 2002

Microbial activity is of primary importance in the bioremediation of metal-contaminated subsurface environments. The principal objective is to develop more expedient and cost-effective methods for biomarker recovery and analysis, using a combination of expanded signature lipid biomarkers (SLB), polymerase chain reaction (PCR) denaturing gradient gel electrophoresis (DGGE), terminal restriction fragment length polymorphism (T-RFLP) analyses of 16S rDNA, and specific genes. These tools are used to define the viable community composition and provide indications of important specific activities relative to the impact of metals and radionuclides on indigenous microbial communities. The testing emplacement of sterile surfaces with and without nutrient sources has been initiated in the well fields of impacted sites—the “bug traps.” After a 2-3 week exposure, the traps are recovered and analyzed. Traditionally, methods employed to monitor microorganisms require ex situ culture analysis of ground-water membrane retentates and sediments, but these methods poorly represent in situ microbial

communities. Phospholipid fatty acid (PLFA) analysis has been utilized to determine shifts in microbial biomass, nutritional/physiological status, and community diversity in situ. For greater specificity, PLFA analysis has been complemented with a PCR-DGGE approach, employing primers that recognize the 16S rDNA of almost all known and inferred bacterial species and of specific functional genes. Sequence analysis of individual bands from DGGE gels was used to provide fine-scale biomarkers and loosely infer the identity of the source organisms, using database searches and phylogenetic methods to relate the complexity, band positions, and relative band intensities of DGGE patterns to contaminant load. Applications to the "Bug Traps" show great promise. The LC/MS/MS analyses of UQ/MK allow monitoring manipulations of in situ terminal-electron-acceptor concentration that are critical to heavy-metal and radionuclide immobilization.

Environmental Electrochemistry: Analyses of Trace Element Biogeochemistry
Taillefert, Martial (Georgia Inst. of Technology, Switzerland); and T.F. Rozan, (Univ. of Delaware) (eds).
Oxford University Press, New York. ISBN: 0-8412-3774-3. American Chemical Society (ACS) Symposium Series 811, 424 pp, 2002

This book examines the usefulness of electrochemical methods for understanding complex natural biogeochemical processes. It describes techniques developed to measure trace metals, redox species, and major ions in fresh and marine waters, hydrothermal vents, sediments, microbial mats, extraterrestrial systems, and at mineral-water interfaces. It will be of use to scientists and researchers who need to describe biogeochemical cycling of trace elements in natural environments.

Evaluation and Testing of Analytical Methods for Cyanide Species in Municipal and Industrial Contaminated Waters
Zheng, A. (Carnegie Mellon Univ.); D.A. Dzombak; R.G. Luthy; B. Sawyer; W. Lazouskas; P. Tata; M.F. Delaney; L. Zilitinkevitch; J. Sebroski; R.S. Swartling; S.M. Drop; J.M. Flaherty.
Environmental Science & Technology, Vol 37 No 1, p 107-115, Jan 2003

The cyanide analytical methods in widespread use for water quality monitoring and evaluation (e.g., total cyanide and cyanide-amenable-to-chlorination) are bulk methods that aggregate a number of cyanide species. As the various chemical forms of cyanide exhibit differential aquatic and human toxicity, these aggregate measurements have limitations for assessing risk associated with cyanide in discharges to receiving waters. Species-specific cyanide analytical methods and some aggregate methods with improved features have been developed but are not yet approved by the EPA for widespread regulatory use. The researchers examined the application of these newer methods to a range of contaminated water types, and demonstrated that the methods perform well even with complex aqueous matrices. Seven methods for the analysis of cyanide in reagent water and different contaminated water matrices were compared and evaluated: methods for weak acid dissociable (WAD) cyanide, free cyanide by microdiffusion, available cyanide, automated WAD cyanide by thin film distillation, metal cyanides by ion chromatography, automated total cyanide by thin film distillation, and automated total cyanide by UV digestion. All of the methods were applied to splits of the same water samples within the same short time window after sampling. Six different groups having expertise with the individual analytical methods participated in the study. The data obtained will help support the case for approval of the newer methods for regulatory use.

Field Evaluation of Underground Storage Tank System Leak Detection Sensors
Farahnak, Shahla Dargahi; Scott Bacon; Raed Mahdi, State Water Resources Control Board, Sacramento, CA.

State Water Resources Control Board, Underground Storage Tank Program, Sacramento, CA. 124 pp, Aug 2002

The State Water Resources Control Board's Underground Storage Tank program staff have conducted an extensive field evaluation of liquid sensors used in leak detection. The evaluation included nearly 800 sensors, representing a variety of manufacturers, operating mechanisms, and UST facility types. Federal regulations require that leak detection equipment be evaluated by an independent third-party testing organization in accordance with recognized protocols; however, these evaluation protocols are designed only to test sensor functionality in a laboratory setting. The objective of the field evaluation was to assess sensor functionality under field conditions. The investigators also set out to determine the adequacy of annual certification testing procedures, and to determine whether sensors in the field perform in a manner consistent with the specifications outlined in their third-party evaluations. The data collected in this field evaluation demonstrate that sensors can be a reliable form of leak detection only when properly installed, programmed, maintained, and operated. Most problems observed were due to improper installation and programming of sensors, poor or infrequent maintenance at UST facilities, ignoring alarms, and tampering with monitoring equipment. Poor design, construction, and maintenance of secondary containment systems were also common. Additionally, sensor design and materials played a role in some of the failures observed. Funding for the field evaluation was provided in part by the U.S. Environmental Protection Agency.
http://www.swrcb.ca.gov/cwphome/ust/docs/sensors/index.html

High-Sensitivity Analysis of Cyanide by Capillary Electrophoresis with Fluorescence Detection
Chinaka, S. (Forensic Science Lab., Ishikawa Prefectural Police Headquarters, Kanazawa, Japan); S. Tanaka; N. Takayama; N. Tsuji; S. Takou; K. Ueda.
Analytical Sciences [Japan], Vol 123, p 649-652, May 2001

A new capillary electrophoresis method for trace cyanide analysis using NDA-taurine derivatization has been developed. The method is highly sensitive and highly selective and is applicable for the analysis of cyanide in blood from a healthy person.
http://wwwsoc.nii.ac.jp/jsac/analsci/pdfs/a17_0649.pdf

Hydrogen as an Indicator to Assess Biological Activity during Trace-Metal Bioremediation
Jaffe, Peter, PI (Princeton Univ.), Derick Brown, John Komlos; Derek Lovley (Univ. of Massachusetts).
DOE-NABIR PI Workshop, 18-20 March 2002, Warrenton, Virginia.
Natural and Accelerated Bioremediation Research Program (NABIR). p 53, 2002

The design and operation of a trace-metal or radionuclide bioremediation scheme requires that specific redox conditions be achieved at given zones of an aquifer for a predetermined duration. Tools are therefore needed to identify and quantify the terminal electron acceptor processes (TEAPs) that are being achieved during bioremediation in an aquifer, and this is done at a high spatial resolution. Hydrogen holds the promise of being a key parameter that can be used to identify TEAPs. Theoretical analysis have shown that steady-state hydrogen levels in the subsurface are solely dependent upon the physiological parameters of the hydrogen-consuming microorganisms, and hydrogen concentrations increase as each successive TEAP yields less energy for bacterial growth. The assumptions for this statement may not hold during a bioremediation scheme in which an organic substrate is injected into the subsurface and where organisms may consume hydrogen and carbon simultaneously. The objective of this research is to gain a basic understanding of the hydrogen dynamics in an aquifer during a trace metal/radionuclide bioremediation scheme. For this purpose, a series of batch studies have been conducted during the first year of this project based on the use of acetate and hydrogen by Geobacter sulfurreducens. In all cases, Fe^{+3} was the electron acceptor. Microcosms were set up to investigate the

utilization of hydrogen and acetate when either of them is the sole electron donor and when both are present and utilized simultaneously as electron donor.

Induced Fluorescence Sensors for Direct Push Systems. Innovative Technology Summary Report
U.S. DOE, Office of Science and Technology. Characterization, Monitoring, and Sensor Technology Crosscutting Program and Subsurface Contaminants Focus Area.
Report No: DOE/EM-0638, 39 pp, Sep 2002

Induced fluorescence sensors can be efficient screening tools for the presence of certain petroleum oils and lubricants (POLs) and nonaqueous phase liquids (NAPLs). When the subsurface media adjacent to the probe are illuminated with ultraviolet light, polycyclic aromatic hydrocarbons (PAHs), if present, will fluoresce in response to this illumination. This fluorescence is transmitted via a fiber-optic cable to a spectrometer or other sensor at the surface. PAHs are commonly found in POLs and certain other organic constituents such as coal tar derivatives. DNAPLs themselves *will not* fluoresce when excited at feasible wavelengths. In many cases, however, PAHs are found in DNAPLs that have been used in cleaning or degreasing operations. Depending on the excitation wavelength(s) of the ultraviolet illumination source, fluorescence may in principle also be obtained from aromatic hydrocarbons with only one or two rings, although in field applications this fluorescence will tend to be dwarfed by that from PAHs with three or more rings. Preliminary evaluation is needed to determine which of these techniques, if any, will be useful for detecting the particular contaminant of concern at each site. The induced fluorescence will have distinct frequency and time spectra depending on the PAHs present and on the exciting frequency. Frequency and/or time domain analyses of the observed fluorescence can be used to distinguish among categories of fluorescing compounds, such as distinguishing fuels from coal tar residues and distinguishing hydrocarbon contamination in general from natural mineral fluorescence. Recent developments utilizing multiple excitation and response frequencies show promise at both identifying and quantifying multiple individual constituents of concern. Among the commercial and other realizations of this principle that exist, the following examples are described in this report: the Rapid Optical Screening Tool (ROST™) developed by Dakota Technologies, Inc. (DTI), Fargo, ND, and marketed by DTI and Fugro Geosciences, Inc.; the Fuel Fluorescence Detector (FFD™) developed and marketed by Applied Research Associates (ARA); and the Site Characterization and Analysis Penetrometer System (SCAPS) Laser-Induced Fluorescence (LIF) Sensor developed by the RDT&E Division of the Naval Command, Control and Ocean Surveillance Center in collaboration with the U.S. Army Waterways Experimental Station and Army Environmental Center and others, including DOE. This report focuses on the demonstration of the use of the ROST™ for DNAPL screening at the Savannah River Site M-Area Settling Basin, Aiken, SC, during 1998. The demonstration provided the basis for a cost analysis. Induced fluorescence techniques also were included in demonstrations of DNAPL characterization techniques at the SRS 321-M Solvent Storage Tank Area during 1998 and at the NASA Launch Complex 34 site at Cape Canaveral Air Station during 1999; the techniques were not successful in the demonstration because of the absence of fluorescing PAHs in the subsurface DNAPLs. Demonstrations of screening for POLs using these techniques were conducted previously by U.S. EPA at the Hydrocarbon National Test Site, Port Hueneme, CA (May 1995) and the Steam Plant Tank Farm at Sandia National Laboratories, Albuquerque, NM (November 1995). EPA has published Innovative Technology Verification Reports on the SCAPS LIF Sensor and the ROST™ system. The demonstrations show that these techniques provide useful as screening tools for POLs. Their usefulness in screening for NAPLs depends on the presence of PAHs in lubricants dissolved in the NAPLs for their fluorescence; a concentration of only 1% PAH or other fluorescing compound in NAPL is sufficient. Because these are screening tools, quantitation is approximate, since the strength of fluorescence depends on the concentration of PAHs in the particular contaminant involved. Calibration using the site-specific contaminant, if available, is required to achieve any quantitation at all. The fluorescence intensity depends also on the nature of the soils present. NAPLs present in the subsurface will be dispersed into blobs and ganglia; since the sensor will measure only the fluorescence of materials

immediately adjacent, the measurements of concentration inherently disregard the heterogeneous nature of contaminant dispersion.
http://apps.em.doe.gov/OST/itsrall.asp

Instrumentation Development, Measurement and Performance Evaluation of Environmental Technologies. Progress Report
Plodinec, John, Principle Investigator, Mississippi State Univ., Starkville.
Report No: FC26-98FT40395-10, 136 pp, Apr 2001

This document reports on the progress of several projects to develop characterization and monitoring technolgies. A significant number of DOE needs are associated with applications requiring small, robust, and sensitive sensors for toxic volatile organic compounds (VOCs). In developing diode laser cavity ringdown spectroscopy (DL-CRDS) for VOC monitoring, a new sample introduction system was constructed and used to obtain quantitative absorption measurements of chlorobenzene in the DL-CRDS system. The detection capabilities of the system correspond to a detection limit of 200 ppb for chlorobenzene. Improvements aimed at improving the system reproducibility and the detection limit are described. The near ultraviolet absorption spectrum of 2-chloro-dibenzo-p-dioxin at ambient temperature has been obtained in the 260 - 310-nm region by cavity ring-down spectroscopy. This is the first cavity ring-down spectrum for a chlorinated dioxin species. Cavity ringdown experiments have focused on achieving a better understanding of the interaction between the ICP plasma and the stable modes of the ringdown cavity. Efforts to improve the laser-induced breakdown spectroscopy (LIBS) calibration for solid samples continues. A transportable calibration test stand is being developed to construct a test train that would be usable for the calibration of optical diagnostic instrumentation. While waiting on delivery of components of a multi-species system for on-line multi-spectral imaging of thermal treatment processes, researchers explored the possibility of applying spectral imaging to long-term monitoring for DOE by recorded spectral images of cotton plant leaves grown under different conditions of nutrient stress. It is anticipated that by selecting appropriate spectral regions or ratios of spectral regions, it may be possible to discern the presence of heavy metal pollutants in plants. Significant progress in using neural networks was made; a program capable of discerning whether or not the species of interest is present in significant quantity is nearing completion. To improve DIAL's thermal imaging system so as to provide in situ monitoring of the thermal distribution inside the core chamber of treatment facility, the effects of the surface emissivity was studied. The software development of an user adjustable control for target surface emissivity was conducted. Search for an NIR camera started.
http://www.osti.gov/bridge/product.biblio.jsp?osti_id=803832

Integrated Particle Handling Methods for Multiplexed Microbial Identification and Characterization in Sediments
Chandler, Darrell P., PI (Analytical Microbiology Group, PNNL, Richland, WA); Craig Criddle (Stanford Univ., Stanford, CA).
DOE-NABIR PI Workshop, 18-20 March 2002, Warrenton, Virginia.
Natural and Accelerated Bioremediation Research Program (NABIR). p 26, 2002

The objective of this project is to develop integrated microbial and nucleic acid detection methods and instrumentation for monitoring metal-reducing microbial communities in subsurface sediments, before and after bio-stimulation. This objective is being met by coalescing recent developments in 16S rRNA microarrays, microfluidic systems, microparticle chemistries, renewable surface techniques, and suspension array technology to address fundamental scientific and technical gaps associated with in-field purification and detection of 16S rRNA from sediments. In the first quarter of the project, the investigators coupled 16S rRNA-targeted DNA and peptide nucleic acid (PNA) oligonucleotides to

avidin-coated and carboxylated 5 μm microspheres, developed direct and indirect labeling methods for target nucleic acids, and established baseline target DNA capture and detection limits in a simplified flow-cytometer instrument. Peptide nucleic-acid probes resulted in 10 to 100 times greater signal intensity and shorter hybridization times in batch capture experiments than identical manipulations with DNA probes. One nanogram of Geobacter 16S rDNA could be captured and detected in as little as 15 minutes in the presence of 1 μg nontarget DNA. Hybridization specificity could be improved through the use of heat or formamide during hybridization. These preliminary results are in keeping with the hypothesis that PNA probes will be more sensitive than identical DNA probes for the automated recovery and direct detection of metal- and sulfate-reducer 16S rRNA and mRNA from sediment extracts. Successful coupling of DNA and PNA probes to two different bead surfaces, and subsequent capture of target DNA in batch capture experiments, provides two different methods to address our tunable surface hypothesis for increasing the direct capture and detection efficiency of metal- and sulfate-reducer 16S rRNA and mRNA. A fluidic system with a custom flow cell was assembled to serve as an automated "front end" for the flow cytometer detector, and methods for automated capture and release of nucleic acids on 5 μm particles in the fluidic system were developed.

Interferences, Accuracy and Reliability of Cyanide Determination Techniques
Adams, M.D.; G.W. Dicinoski; B.M. Joja; P.W. Lotz.
AMIRA P497A, Quarterly Progress Report No. 1, 1998

The AMIRA P497A project ran for two and a half years, with its final report published in 2000. The project was undertaken to clear up uncertainties about what happens to cyanide after it finishes its leaching job, as the use of cyanide in gold processing is becoming increasingly controversial. It was a bi-national effort with both Australian and South African research groups and sponsors. The collaborating researchers were from the Parker Centre, the Chemistry Centre (WA), Mintek, and Insight Modelling Services. The sponsors included gold companies, governmental regulatory authorities and cyanide producers. How do the real environmental risks of cyanide in mining compare to the perceived risks? The researchers worked to better their understanding by improving cyanide analysis methods and by computer modeling and systems analysis.

Investigation of Selected Detectors for Application on Continuous Emissions Monitoring System: Project Summary
Dayton, Dave-Paul; Joan T. Bursey; Stephanie B. Phillipp; Eastern Research Group, Morrisville, NC.
Report No: EPA/600/SR-97/014, 2 pp, Mar 1997

The development of a prototype emissions monitoring instrument to provide continuous or semicontinuous quantitative measurement of total gaseous nonmethane organic carbon (TGNMOC) emissions from stationary sources will provide better characterization and control of compounds listed in Title III of the Clean Air Act Amendments of 1990. To meet this goal, a search was initiated to identify detection systems for TGNMOC that are both simple to use and accurate for a wide range of organic compounds. The measurement of oxygenated compounds is of particular interest since many emission sources emit a considerable volume of these compounds. Several detector systems are marketed as capable of measuring TGNMOC. In this report, data are presented on the laboratory evaluation of a Catalyzed Flame Ionization Detector, a Thermionic Ionization Detector, an Oxygen-Flame Ionization Detector, and an Elemental Analyzer for TGNMOC measurement. Fourier Transform Infrared Spectroscopy was also evaluated as a candidate detector. The primary performance requirement was that the detectors produce equal response for all organic compounds in a mixture, including oxygenated compounds, based on the number of carbon atoms in the compounds. None of the detection systems evaluated met this goal. Some detectors were successful for many classes of organic

compounds, but oxygenated compounds presented a challenge that none of the detection systems could master.
http://www.epa.gov/ttn/amtic/dira.html

Leak Detection System For Double Containment Piping Pinpoints Leaks In Seconds
Pollution Online News, 14 Jan 2003

A state-of-the-art Leak Detection System from Asahi/America, Inc., the Wet Process People™, pinpoints leaks quickly to provide protection for double containment piping Systems. Suitable for chemical process and hazardous waste piping, the Leak Detection System adheres to EPA guidelines, protecting against potential serious leaks and spills by sounding an alarm should a leak occur. Asahi has teamed up with PermAlert to provide two fully engineered, state-of-the-art leak detection systems: PAL-AT™ and LiquidWatch™. With both methods, sensors are tied to a master panel that monitors the piping continuously, and can be integrated into any plant control system. The PAL-AT™ system consists of a continuous cable that can incorporate low point probes and float switches. The system has the ability to differentiate between a cable break and a leak, with panels capable of monitoring from 2,000 feet of continuous cable to 120,000 feet of cable in 8 separate lines (15,000 feet each). It can be dried in place, eliminating the need to repull or replace wet cable, and it can be calibrated while wet spots are drying. The LiquidWatch™ system is a flexible, modular, low point system based on inline probes, which responds in seconds after probe contact with organic liquids or water. Hydrocarbon fumes or water vapors have no effect, virtually eliminating false alarms. The system can be configured with up to 64 probes and 16 alarm relays. Asahi provides customers with system design and layout assistance, on-site training, installation assistance, and final commissioning of all Leak Detection Systems. Contact: Asahi/America, (877) 24-ASAHI.

LIBS—A New Chemical Analytical Technology for the In-Field Analysis of Trace Metals
Harmon, R.S. (U.S. Army Rsch. Lab., Research Triangle Park, NC); P.D. French (ADA Technologies, Inc., Littleton, CO); B.W. Peterson (U.S. Army Rsch. Lab., Aberdeen Proving Ground, MD), A.W. Miziolek, and K.L. Mcnesby.
GSA Annual Meeting, 5-8 November 2001, Paper No. 77-0

Laser-induced breakdown spectroscopy (LIBS) is an emerging technology for minimally-destructive, in situ chemical analysis. A solid-state, short-pulsed laser is focused on a sample to generate a high-temperature plasma. Upon cooling, the excited atomic, ionic, and molecular species produced in the plasma emit radiation that is characteristic of the elemental composition of the volatilized sample. A laboratory bench-top LIBS system at the Army Research Laboratory has been used to survey trace metals in a variety of geomaterials including rocks, soils, ores, and desert rock varnish. A field-portable LIBS system has been developed by ADA Technologies for real-time environmental analysis, based upon the use of a hand-held laser-bearing fiber optic probe and a briefcase-size analyzer system containing a spectograph with a thermoelectrically-cooled 250x12 element CCD, that can be powered by either a 115V AC current or a 12V battery. The field-portable LIBS unit, which has a 20nm spectral range, was purposely designed for the detection of lead (Pb). It has been field tested and demonstrated using both the 220.4 nm and 405.8 nm Pb emission lines for soils contaminated with Pb from the demilitarization of small-arms ammunition by burning at Sierra Army Depot, CA, and the leaching of exterior painted surfaces of buildings at Fort Carson, CO. Work is presently in progress to optimize the instrument for rapid, in-situ surveying and the quantitative assessment of trace metals across a wide range of natural field environments and conditions.

Miniature, Low-Cost Liquid Level Sensors Ideal for OEM Applications

Pollution Online News, 8 Jan 2003

Pollution Online News notes that Scientific Technologies, Inc., Automation Products Group, Logan, UT, has introduced LF Series Miniature Liquid Level Sensors. The sensors provide reliable operation in small tanks and containers within a wide range of liquids. They feature a utility design for shock resistance and long life. The LF series is a level sensing/switching solution for OEM and large volume applications. Industry examples include food and pharmaceutical, automatic vending machines, photocopiers, small collection tanks, miniature pumping stations, pilot plants, electronic parts plating, and similar small system applications.

More Metal Cyanide Species: Detection of AlNC ($X^1\Sigma^+$) Toward IRC +10216
Ziurys, L.M. (Univ. of Arizona, Tucson), C. Savage, J.L. Highberger, A.J. Apponi; M. Guelin (IRAM, St. Martin d'Heres, France); J. Cernicharo (CSIC, Inst. de Estructura de la Materia, Madrid, Spain).
The Astrophysical Journal, Vol 564, p L45-L48, 1 Jan 2002

A new metal-containing species, AlNC, has been detected toward the circumstellar envelope of the late-type carbon star IRC +10216, using the IRAM 30 m telescope. A fourth metal cyanide/isocyanide compound was discovered in this object, along with MgNC, MgCN, and NaCN. The data suggest that cyanide/isocyanide species are the major molecular carriers of metals in circumstellar gas.
http://www.chem.arizona.edu/faculty/ziur/alncspace.pdf

NAPL Identification and Vertical Distribution Using the Rapid Optical Screening Tool (ROST™) and Cone Penetrometer Testing
Jengo, J.W., RETEC, King of Prussia, PA.
The Professional Geologist, p 8-10, Jul 1996

The ROST™ system, in conjunction with conventional cone penetrometer testing, was successfully applied at a refinery to characterize both the complex stratigraphy and the distribution and nature of petroleum hydrocarbon plumes. The investigation determined the following: no DNAPLs were present at the site; most of the LNAPL occurrences were diesel and gasoline products with higher molecular weight hydrocarbons (tank bottoms) in the former disposal areas; occurrences of hydrocarbons were related to the same hydrocarbon plume; and the thickness of the NAPL plumes or their associated smear zones in tidally-influenced areas. Costly drilling and sampling in the deeper aquifers, which are normally required for DNAPL investigations, were elimated, making the ROST™ system an efficient and cost-effective method for identifying and delineating subsurface hydrocarbons at this site.

New Amphibious Craft Promotes Better Groundwater Sampling
Emerson, Mia.
Environmental Update, Vol 12 No 3, Summer 2000

In April, the USGS Hoverprobe 2000 performed before a crowd of invited visitors at Aberdeen Proving Ground, MD. The Hoverprobe is the first combination of an amphibious air cushion vehicle with multisonic drilling to allow sediment and ground-water sampling in previously inaccessible environments. Aberdeen and USGS are working together to better define the vertical and lateral extent of ground-water contamination in that area. The craft collected continuous sediment cores and ground-water samples up to depths of 60 feet. The Hoverprobe's drill, plunging directly through an opening in the vehicle's center, uses high frequency vibrations to increase effectiveness and minimize contamination of sediments. No liquids are necessary, so scientists can maintain the integrity of the sediment samples. Also, the Hoverprobe generates no drill cuttings, which minimizes waste that would

need to be disposed of. The Hoverprobe developers--USGS, Hovertechnics, Inc., and MPI Drilling--have pursued a patent for the craft, and plans are underway to build another for the USGS. In the field, a truck pulls the Hoverprobe to a convenient location. Once shifted into hover mode, it slides off the trailer and can be driven over land, water, or mud to the appropriate sampling area. Besides riding on a cushion of air, the 21-foot-long craft can travel more than 30 miles per hour and carry 2000 pounds. The craft can enter remote areas and collect samples needed to conduct ground-water plume delineation. Contact: Don Queen, USGS driller, dqueen@usgs.gov; Dan Phelan, djphelan@usgs.gov; or John Wrobel, jwrobel@dshe.apg.army.mil.

New Catalytic DNA Biosensors for Radionuclides and Metal Ions
Lu, Yi (PI), Dept. of Chemistry, Univ. of Illinois, Urbana.
DOE-NABIR PI Workshop, 18-20 March 2002, Warrenton, Virginia.
Natural and Accelerated Bioremediation Research Program (NABIR). p 19, 2002

The project proposes to develop new DNA biosensors for simultaneous detection and quantification of bioavailable radionuclides (e.g., strontium, uranium, technetium, and plutonium) and metal contaminants (e.g., lead, chromium, and mercury). The sensors will be highly sensitive and selective, not only for different metal ions, but also for different oxidation states of the same metal ion. They will be applied to the on-site, real-time assessment of concentration, speciation, and stability of radionuclides and metal contaminants during and after bioremediation. To achieve this goal, the researchers will employ a method called "in vitro selection" to search for catalytic DNA molecules that are highly specific for radionuclides or other metal ions. Comprehensive biochemical and biophysical studies will be performed on the selected DNA molecules. The findings from these studies will elucidate the structure/function relationship in catalytic DNA and thus facilitate the design of improved sensors. The DNA will be labeled with fluorescent donor/acceptor pairs to investigate, and to signal, the structural changes upon metal ion binding. Once a collection of individual DNA sensors is identified, each specific for a particular metal ion at a particular concentration range, they will be assembled into a DNA microarray for the simultaneous detection and quantification of radionuclides and metal contaminants. The methodology has been used to develop a highly sensitive and selective DNA biosensor for Pb^{+2}. The principles demonstrated in this work can be used to obtain catalytic DNA biosensors for other metal ions as well.

Novel Sensitive Spectrophotometric Method for the Trace Determination of Cyanide in Industrial Effluent
Nagaraja, Padmarajaiah (Univ. of Mysore, Manasagangotri, Mysore, India); Mattighatta S. Hemantha Kumar; Hemmige S. Yathirajan; Jainara S. Prakash.
Analytical Sciences [Japan], Vol 18 No 9, p 1027-1030, Sep 2002

A new sensitive spectrophotometric method has been developed for the trace determination of cyanide with ninhydrin (NH) in an alkaline medium. The optimum reaction conditions and other important analytical parameters have been investigated. The results obtained by using the proposed method for environmental samples agree well with those obtained by the Aldridge standard method.
http://wwwsoc.nii.ac.jp/jsac/analsci/abst18-09.html

Optimisation of the Experimental Conditions of a New Method, Based on a Quartz Crystal Microbalance, for the Determination of Cyanide
Gomes, M.T.S.R.; A.A.F. Silva; A.C. Duarte; J.A.B.P. Oliveira.
The Analyst, Vol 122 No 10, p 1139-1141, 1997

This paper describes two procedures for cyanide determination. A modified simplex algorithm was used to optimize the experimental conditions with regard to solution pH, temperature, and N_2 flow rate. Sensitivity increases of 1.5 and 1.7 were obtained for the two procedures with 27 and 12 experiments, respectively. Under the optimized conditions, the calibration graphs were linear for 0.05-0.5 and for 0.24-0.86 ppm cyanide for the two procedures, respectively.

Review of Current Practice in Characterization and Monitoring
Ebadian, M.A., National Energy Technology Lab., Pittsburgh, PA.
Report No: FG21-95EW55094-04, 39 pp, Jan 2001

The remediation process often cannot begin or even be planned until characterization is complete, and monitoring is essential to verify the progress of remediation. Development of new characterization and monitoring technologies is time-critical to remediate difficult or dangerous sites. The main task of the Characterization, Monitoring, and Sensor Technology Crosscutting Program (CMST-CP) is to develop and deploy innovative characterization and monitoring technologies that improve performance and reduce personnel exposure, cost, and detection limits. Different proposals for new technologies to decide which ones to develop or deploy must have their cost and performance data compared to that of the baseline technology. The goal of this project is to facilitate the direct comparison of new technologies to the baseline technology by documenting the current practices for site characterization and monitoring at DOE sites and presenting the information in an easy-to-use, concise database. The database will assist the CMST-CP and others in evaluating or designing new technologies by identifying the baseline technologies and describing their performance and cost. The purpose of this document is to report on the completion of this project and to describe the database. Section 2.0 describes the data assessment methodology. Section 3.0 presents the database and serves as a user manual. Section 4.0 lists the references used for each baseline technology in the database. The full references can be found in the Appendix.
http://www.osti.gov/bridge/product.biblio.jsp?osti_id=790966

Simple Techniques for Assessing Impacts of Oil and Gas Operations on Public Lands: A Field Evaluation of a Photoionization Detector (PID) at a Condensate Release Site, Padre Island National Seashore, TX
Otton, James; Robert A. Zielinski, U.S. Geological Survey, Lakewood, CO.
8th Annual International Petroleum Environmental Conference, 6-9 November 2001, Houston, TX. 32 pp, 2001

Field-portable instruments provide real-time data and allow the field investigator to extend an assessment beyond simply locating and mapping obvious impacts. Field investigators can examine sites for the presence of hydrocarbons in the subsurface using a soil auger and a photo-ionization detector (PID). The PID measures volatile organic compounds (VOC) in soil gases. This allows detection of hydrocarbons in the shallow subsurface near areas of obvious oil-stained soils, oil in pits, or dead vegetation. Background sampling should be done for comparison with impacted areas. This paper describes sampling techniques and results of condensate occurrence in sandy soils at a production site at the Padre Island National Seashore in Texas, as well as at five sites in the Big South Fork National River and Recreation Area in northeastern Tennessee. Field results show that sealing auger holes with a clear, rigid-plastic tube capped at the top end and sampling the soil gas through a small hole in the cap increases the soil gas VOC signature compared to sampling soil gases in the bottom of an open hole. This sealed-tube sampling method thus increases the contrast between the VOC levels within a contaminated area and adjacent background areas. The tube allows the PID air pump to draw soil gas from the volume of soil surrounding the open hole below the tube in a zone less influenced by atmospheric air. In an open auger hole, the VOC readings seem to be strongly dependent on the degree

of diffusion and advection of soil gas VOCs into the open hole from the surrounding soil, a process that may vary with soil and wind conditions. Making measurements with the sealed hole does take some additional time (4-7 minutes after the hole is augered) compared to the open-hole technique (1-2 minutes). The rigid-plastic tube technique used to survey for soil gas VOCs across the entire Padre Island site showed that condensate has affected at least 0.28 acres (0.12 hectares). Because sampling along the northwest side of the site did not get down to background values, the contaminated area may extend northwest of the surveyed area.
http://ipec.utulsa.edu/Ipec/Conf_toc.html

Simplified Cyanide Analysis Using Microdistillation
Munsinger, Roger A., Brinkmann Instruments, Inc., Westbury, NY.
American Environmental Laboratory, p 21, Aug 1998

The Eppendorf® MicroDistiller (Brinkmann Instruments, Inc., Westbury, NY) is capable of performing rapid, programmable distillation of up to six samples. Distillate is collected in 10-mL volumetric flasks and a photometric determination is performed. The user is able to add liquid matrices and solid substances to the sample vial. Investigations were carried out to establish the suitability of the device for analyzing simple and complex cyanides. A comparison study was performed between the results obtained using the Eppendorf MicroDistiller and results obtained using conventional methods. The tests show that microdistillation in combination with a photometric method produces results that concur very closely with those obtained by conventional methods. The results reveal that complex cyanides can be determined ideally and that miniaturization has no adverse effect on accuracy values (determination limit: 5 ppb).

Subsurface Fate and Transport of Cyanide Species at a Manufactured Gas Plant Site
Ghosh, Rajat S. (Carnegie Mellon Univ., Pittsburgh, PA); David A. Dzombak; Richard G. Luthy; David V. Nakles.
Water Environment Research, Vol 71 No 6, p 1205- , 1999

Studies of a plume of cyanide-contaminated ground water in an aquifer underlying an MGP site indicate that (1) cyanide emanating from MGP oxide-box wastes occurs primarily in the form of ironcyanide complexes, (2) these complexes are stable under the conditions in the aquifer, and (3) they are transported as nonreactive tracers in the sand and gravel porous media comprising the aquifer. The stability of iron-cyanide complexes in the dark and at neutral pH conditions is suggested by the field data and has been confirmed via batch tests in the laboratory. Modeling results suggest that dilution may be the only natural attenuation mechanism for cyanide in sand/gravel aquifers at MGP sites. The hypothesis of nonreactivity of the dissolved iron-cyanide complexes that dominate the cyanide speciation in the aquifer will be field-tested.

University of Rhode Island Scientist Tracks Pollution with Electricity
Davis, Paul.
Providence Journal, 9 Dec 2002

Reinhard Frohlich, a University of Rhode Island professor of geosciences, reports that pollutants at a site can be located by relying on a simple electric current. To find hidden toxins, Frohlich drives two metal spikes connected to an electric current into the ground. After the spikes are buried, the voltage between the spikes can be measured to determine if an underground water source or soil is polluted. Organic cancer-causing compounds such as benzene, xylene, and phenol do not conduct electricity, Frohlich says, so resistance to the current increases significantly in areas where an aquifer is polluted.

Though the application is new, the method is based on scientific work done more than 70 years ago. The U.S. EPA provided a $55,000 grant to test the system at the Picillo pig farm in west Coventry, a Superfund waste dump. The state Department of Environmental Management, the EPA and the chemical and trucking companies responsible for the dumping have already paid about $20 million to remove contaminated soil and barrels of hazardous chemicals.

Unregulated Contaminant Monitoring Regulation: Approval of Analytical Method for Aeromonas; National Primary and Secondary Drinking Water Regulations: Approval of Analytical Methods for Chemical and Microbiological Contaminants
Federal Register, Vol 67 No 209, p 65888-65902, 29 Oct 2002

EPA is approving seven of eight additional industry-developed analytical methods proposed to support previously required NPDWR compliance monitoring, among them two methods for the determination of cyanide. This rule approves a method using a micro-scale hard distillation apparatus followed by colorimetric determination of total cyanide and a method using an ultra-violet digester system for the determination of total and available cyanide, to support monitoring required under 40 CFR 141.23 (k)(1). The description of the Kelada 01 Method for cyanides can be obtained from NTIS: "Kelada Automated Test Methods for Total Cyanide, Acid Dissociable Cyanide, and Thiocyanate," Revision 1.2, EPA 821-B-01-009, NTIS: PB 2001-108275, Aug 2001. The description for the QuikChem Method 10-204-00-1-X for total cyanide is available from Lachat Instruments: "Digestion and Distillation of Total Cyanide in Drinking and Wastewaters Using MICRO DIST and Determination of Cyanide by Flow Injection Analysis," Revision 2.1, 30 Nov 2000. Lachat Instruments, Milwaukee, WI, 414-358-4200.

The Uranium Immunosensor: Functional Assessment and Reagents to Enhance Performance
Blake, Diane A. (PI); Haini Yu, Tulane/Xavier Center for Bioenvironmental Research, Tulane Univ. Health Sciences Center, New Orleans, LA.
DOE-NABIR PI Workshop, 18-20 March 2002, Warrenton, Virginia.
Natural and Accelerated Bioremediation Research Program (NABIR). p 8, 2002

In pursuit of accurate detection and measurement of organics, metals, and other toxic elements prior to, during, and following the bioremediation process, this project seeks to develop and refine portable immunosensor-based assays with the following characteristics: delivery of reliable data in real time (i.e., <1 hour), field-ready (i.e., simple, durable, and accurate), inexpensive (i.e., <$100/test and <$5,000 for the initial equipment investment), and minimally invasive. There are three aims for the present project period. (1) Test and validate the present uranium immunosensor-based assay and develop protocols for its use at the NABIR Field Research Center in Oak Ridge, Tennessee. (2) Develop new protein reagents that will provide superior performance in the hand-held immunosensor. (3) Develop new monoclonal antibodies for DTPA and Cr(III) or Hg(II). A portable sensor for U(VI) that is under development employs a monoclonal antibody with specificity for chelated U(VI) and an instrument built by Sapidyne Instruments, Inc. (Boise, ID). In this method, the fluorescently labeled antibody is permitted to equilibrate with a soluble metal-chelate complex derived from the environmental sample. Then the equilibrium mixture is rapidly passed through a disposable microcolumn that contains an immobilized capture reagent. When the fluorescent signal is plotted versus time, the slope of the line is inversely proportional to the concentration of UO2 +2 in the original solution. The prototype immunosensor could detect soluble UO2 +2 at concentrations from 10 to 100 nM (2.5 to 24 ppb). The maximum coefficient of variation in the linear portion of the assay was 6.5%. New capture reagents have been developed from chemically functionalized particles of poly(methyl methacrylate). This chemical modification procedure enhanced by ~30-fold the capture of the fluorescently labeled antibody. Studies are underway to incorporate these new supports into the handheld sensor.

Using Chemical Oxidation to Delineate a Contaminate Plume from a Pipeline Release
Buckhahn, James R. (Terracon); William L. Lundy (BMS, Inc., Tinley Park, IL).
8th Annual International Petroleum Environmental Conference, 6-9 November 2001, Houston, TX. 7 pp, 2001

Because conventional plume delineation techniques had failed to locate the boundaries of a plume caused by a pipeline release beneath an alfalfa field in rural Illinois, the BIOX® chemical oxidation process from BioManagement Systems, Inc. (BMS), which is more commonly applied as a remediation technology, was evaluated to assess its usefulness as a contaminant delineation technique. One of the components in the proprietary BIOX® mix is an oxidizer. In the presence of petroleum hydrocarbons, the oxidizer causes a chemical reaction to occur, and the resulting effervescence, along with its coloration, appearance, and off-gassing (i.e., odor) can be used as a quantitative indicator of potential hydrocarbon impact at that location. The assessment/injection process was started in the known or suspected areas of high impact and proceeded outward in a criss-cross grid until observations of the chemical reaction indicated a lack of substantial impact. The depth of each injection was based on water table elevations at the time of injection, generally between 10 to 15 feet below ground surface. The BIOX® solution was prepared on the site for direct injection into the soil by direct push drilling technology. A patented high pressure pumping/mixing unit, also developed by BMS, injected the agent at the prescribed depth. Twenty gallons of BIOX® solution were delivered to each injection point. Based on the BIOX® assessment as compared to previous assessment data and free-product recovery efforts, free-product pooling appeared to exist both at the water table interface and within non-homogenous pockets in vadose zone soils. The BIOX process performed well as an economical site characterization tool. Contact: BMS, Inc., (708) 614-1089.
http://ipec.utulsa.edu/Ipec/Conf_toc.html

Sampling and Remedial System Design Optimization Through Passive Soil Gas Screening
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2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 87, 2001

This paper discusses the use of a passive soil gas (PSG) survey employing innovative Gore-Sorber (Gore-Tex) technology to determine the extent of ground-water and soils contamination and remedial investigation solutions for a naval facility with dissolved contaminants and NAPLs in ground water and soils. Chemical-specific PSG modules, placed in grids, were used to screen potential contaminant source areas and geometries of the contaminant plume(s). Results from the PSG screening survey helped to reduce and optimize the number of soil and ground-water sampling locations required to develop risk-based remedial alternatives. Each module comprises sensitive chemical-specific resins encapsulated in a Gore-Tex sleeve and is inserted 3 feet into the ground in a pre-drilled hole. Because the modules absorb soil gases over a two-week period under atmospheric pressures and temperatures, the data are not biased by soil texture, moisture, or changing ambient surface and subsurface conditions. After two weeks, the modules were removed and analyzed by GC/MS. The length of time from module installation through report delivery was six weeks. This EPA-accepted PSG survey screening technology provides a low-cost expedient method of reducing characterization costs and optimizing sampling and remedial system design and monitoring requirements.

Sample Design Optimization and Identification of Contaminant Plumes and Subsurface Structures Through Use of Multi-tool Surface Geophysics

Monks, K. (Tetra Tech EM Inc., Albuquerque, NM); M.D. Godwin (Washington Group International, Inc., San Francisco, CA).
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 87, 2001

Multi-tool surface geophysics (resistivity, seismic refraction/reflection, gravity, magnetics) were employed at an experimental fire-fighting training facility at a naval installation to determine the presence and geometry of contaminant plumes and subsurface characteristics of lacustrine fill and bedrock, including morphology, faulting,and potential pathways for contaminant migration. The site is comprised of fine-grained Pleistocene playa deposits overlying Mesozoic granodiorite. The study site has one known and several suspected source areas: organic and inorganic contaminants in soil and ground water, and a NAPL and dissolved-phase contaminant plume 800 ft long by 200 ft wide. The objectives of the study were to identify potential sampling targets, optimize sampling depths, and eliminate the installation of unnecessary exploratory borings and wells. Results of the ground resistivity survey were used to identify isolated plume areas (NAPL) within a larger dissolved ground-water plume, model the underlying bedrock surface, and show that the bedrock was unfractured. Seismic refraction results helped map the underlying competent bedrock surface and show that weathered bedrock was not present. Results from both geophysical surveys were combined to develop a depth-to-bedrock map to help identify contaminant pathways, eliminate exploratory borings >100 feet deep, and determine specific sampling locations.

A Cost-Effective Approach to Multi-Parameter Hydrologic Monitoring to Characterize Groundwater Flow Conditions
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This presentation introduces a cost-effective approach to characterizing ground-water movement horizontally and vertically within three hydrogeologic zones. Continuous water levels and velocities were continuously measured with pressure transducers and velocity sensors at strategic locations along the property boundary, and ground-water levels were measured regionally in on- and off-site wells to characterize ground-water flow within a 36-square mile area. In situ ground-water velocity sensors (developed for DOE) and pressure transducers in monitoring well pairs were used to estimate ground-water velocities and gradients in three dimensions. Data collected continuously from the velocity sensors and pressure transducers, coupled with the water level data collected quarterly from a regional monitoring well network, served to monitor changes in horizontal and vertical ground-water gradients and velocities, to determine the direction and rate of ground-water movement from the property boundary to an adjacent community, and to provide particle tracking estimates. This approach provides greater coverage over a longer duration of time than conventional aquifer testing, which is limited to a discrete zone of influence during a “snapshot” in time.

Differential Thermal Fiber Optic Sensors: A New Approach to Distributed Soil Moisture Monitoring for Landfill Covers and Barriers
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To support the monitoring of a mixed waste landfill at Sandia National Laboratories in Albuquerque, NM, the authors designed a soil moisture system based on a commercial differential-thermal optical

fiber system used in oil wells. The optical fiber system consists of an optical fiber line and an encasing stainless steel tube, which together are emplaced along layers in the landfill. The basis of this system is that a change in soil water content causes a change in the thermal conductivity of the soil. When constant power dissipates from a line heat source (in this design the electrically conducting stainless steel tubing), the temperature increase near the fiber and tubing will depend on the thermal conductivity of the surrounding soil. This method is similar to an electrical thermistor-based method, the Campbell 299 Soil Water Potential Probe. The optical fiber system was calibrated to the expected ranges of soil moistures in a field test adjacent to the landfill.

Using Rapid Sediment Characterization Technologies to Expedite the Marine Site Characterization Process

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Rapid sediment characterization (RSC) technologies are field-transportable analytical tools that provide real-time or near real-time data and reduce the time and cost of marine sediment characterization. RSC technologies—including x-ray fluorescence (XRF) for metals, ultraviolet fluorescence (UVF) for PAHs, immunoassay for PCBs, and QwikSed bioassay for biological effects— have been refined and implemented by the Navy to delineate areas of concern, fill information gaps, and assure that expensive, certified laboratory analyses are targeted in areas where they will have the greatest possible value. Field analytics (often labeled screening tools) do not totally replace standard laboratory analyses, but more efficiently guide placement of the limited number of expensive laboratory samples that are generally available. The ability to integrate, interpret, and present screening results in an effective manner is critical to successfully using these tools to assist with the site characterization process. RSC analyses allow better delineation of contaminant distribution by providing higher data density in a time- and cost-effective manner, without relying solely on costly laboratory analyses. Results from several Navy sites are presented to demonstrate the range of utility of these techniques. For example, RSC tools were used at Hunters Point Shipyard to map contaminant distribution and support development of a stratified random sampling design for a more detailed study.

The Use of X-Ray Fluorescence Spectrometry to Support Long-Term Monitoring of Heavy Metals Migration at a Wetlands Site

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Rapid sediment characterization (RSC) tools—X-ray Fluorescence (XRF) for metals, UV Fluorescence for PAHs, Immunoassay for PCBs—are being used at sediment sites to facilitate the ecological risk assessment process. Two different applications of XRF Spectrometry supported a five-year periodic review assessment at the Litigation Area at Naval Weapons Station Seal Beach Detachment Concord, CA. The field investigation included a baseline ecological risk assessment and provided additional data to examine the migration of heavy metals in the wetlands. During the first phase of the field investigation, field-portable XRF was used on site to provide rapid measurements of the relative concentrations of Zn and Cu at the most contaminated portions of the site. These data were used to select samples for the amphipod bulk sediment bioassays. The second phase of the project involved the vertical delineation of metals concentrations on the marsh surface and in the ditches and sloughs. For this phase, a benchtop XRF analyzer was used in the laboratory to quantitatively evaluate

concentrations in sections of the surface sediment core samples. The versatility of this analytical technique provided the ability to address different data requirements in a cost- and time-effective manner.

Plume Delineation and Monitoring of Natural Attenuation Processes via In Situ Flux Measurement
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Research has been conducted in Canada over a two-year period to develop an innovative sampling technique for petroleum-contaminated sites. This new method quantifies the rate at which vapors or gases are produced during a particular period of time under specific conditions of ventilation. Traditional soil-gas surveys evaluate concentrations of specific vapors that are in chemical equilibrium with dissolved, sorbed, or free products in the media. The new proposed sampling technique involves purging the soil with a non-contaminated gas in the vicinity of a sample probe for few minutes. The soil-gas purge affects the gas-liquid-soil equilibrium, causing sorbed and dissolved vapors to transfer to the gas phase. During a period when the static equilibrium is unbalanced, the rate at which vapor contaminants are transferred to the soil gas phase is estimated. After this stabilization period, the purge is reduced or stopped altogether. Rebounds after the purging period indicate if petroleum products are present beside the sampling point. This method constitutes a major improvement for plume delineation at low cost. It delivers results on site within 10 minutes and investigated wastes are almost eliminated. More recently, this new sampling approach has been further developed for the saturated zone. Rebounds are used to estimate in situ flux rates of oxygen and biogenic gases. The primary advantages of evaluating biodegradation processes with this method include better estimates of reactant availability and daughter compounds production rate across a plume, less interference from temporal and spatial differences in hydrologic and geochemical conditions, data that are produced on a real-time basis, and reduced overall monitoring cost of the natural attenuation option.

Electrical Resistivity Tomography Imaging of a Colloidal Silica Grout Injection
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DOE investigated the use of colloidal silica to create a viscous liquid barrier for in situ containment of radioactive waste. As part of this work, electrical resistivity tomography (ERT) was investigated for verification of the grout placement. ERT techniques for imaging viscous liquid barriers created using colloidal silica grout were field-tested following a barrier emplacement carried out in 1998 at Brookhaven National Laboratory (BNL). The results of this effort indicated ERT might be used to verify placement of the grout. In 1999, as part of the second phase of the demonstration in which a colloidal silica barrier was to be placed around a portion of the Brookhaven Linear Accelerator Isotope Producer at BNL, a series of controlled injection experiments were completed on a laboratory scale at the MSE test facility in Butte, MT. ERT was used to map one series of these injections in a sand tank designed to study the interaction between adjacent grout injections. The results of the investigation showed that ERT could be used to accurately map the extent of the colloidal silica grout during the injection process.

Analysis of Verification Data from the NTISV Demonstrations at Los Alamos National Laboratory using the Data Correlation Program FUSION.M
Reichhardt, D.K. (CH2M Hill Hanford Group, Inc., Richland, WA); M. Ewanic (MSE Technology Applications, Inc., Butte, MT).
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 73, 2001

Verifying the quality of subsurface waste stabilization and/or containment structures often involves the acquisition of several data types. Typically, each data set is independently processed and interpreted, which can lead to inconsistencies in the assessment of the quality of the structure. As a result, DOE has funded projects involving "data fusion" as applied to site characterization, whereby multiple data sets acquired from a common site are mathematically combined into a single data set. MSE developed a "data fusion" program, FUSION.M, which correlates 2- or 3-dimensional data sets. The program allows data representing various attributes of a subsurface to be read and correlated, and the resulting product is a single data set showing the most likely shape of the structure. The FUSION.M program was employed as part of the non-traditional in situ vitrification cold and hot demonstrations performed at Los Alamos National Laboratory, NM, during fiscal years 1999 and 2000. Results indicated that the program produced a more accurate image of the subsurface structure than any of the single data sets were able to do.

Microchemical Sensors for In situ Monitoring and Characterization of Volatile Contaminants
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This paper presents the development of a microsensor monitoring system that can be used to monitor and characterize volatile organic contaminants in the subsurface. A microchemical sensor that employs an array of chemiresistors is packaged in a unique, waterproof housing designed to protect the sensor from harsh subsurface environments, including completely water-saturated conditions. The array of sensors is calibrated to provide "training sets" for pattern recognition of various chemicals and chemical mixtures. The sensors and packaging have been tested in laboratory environments, and unique characterization methods are being developed with contaminant transport models and time-dependent, in situ sensor data to identify the location of the contaminant source. Additional characterization methods that can be employed during application of soil remediation methods such as soil venting are also being tested to determine the extent and composition of contamination.

A Microbial Screening Method for Heavy Metal Contamination in Stream Sediments
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During the summer of 1998 at DOE's Savannah River Site, sediment samples were collected from Four Mile Creek (FMC) every 200 m from just below a cluster of chemical seepage basins to ~14 km downstream. FMC has a documented history of heavy metal contamination with mercury inputs ranging from 0.45 to 9.07 kg/year. Previous research has indicated a positive association between heavy metal tolerance and antibiotic resistance in bacteria collected from natural environments. The results for FMC confirm this reported relationship, and statistical modeling and geostatistical variography further show that metal-contaminated stream reaches can be discriminated from uncontaminated reaches in FMC

based on the incidence of antibiotic resistance.These preliminary findings suggest that a biological (i.e., microbial) screening method could be developed to spatially identify metal-contaminated stream sediments. In addition, if the relationship between a specific metal and antibiotic can be modeled, the screening method also can allow quantitative estimates of the average metal concentration for a given reach of stream.

Intercode Comparisons for Simulating Water Balance of an Engineered Cover
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Numerical modeling is generally required to evaluate proposed cover designs and to estimate long-term performance of covers. A variety of codes are available to simulate water balance of engineered covers; however, information on intercode comparisons is limited. This study compared the characteristics and performance of HYDRUS, SHAW, SoilCover, SWIM, Unsath, and VS2DT. The codes were used to simulate the water balance of capillary barrier that is being monitored at a site near El Paso, TX. Factors that differ among these codes include graphical user interfaces, user friendliness, dimensionality, upper and lower boundary conditions, hydraulic properties, and processes (liquid flow, vapor flow, hysteresis). Simulation results from all codes reasonably approximated the measured field water balance. The main difference among the various codes was in the partitioning of precipitation into evaporation and soil water storage. The intercode comparisons are being used to identify important attributes of codes to simulate infiltration into engineered covers. Such information can lead to recommendations for modifications of existing codes and/or development of new codes.

The Use of the Membrane Interface Probe (MIP) for expedited DNAPL Characterization
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The Membrane Interface Probe (MIP) is a rapid, high-resolution in situ VOC screening technology that provides real-time data about relative VOC concentrations and soil lithology, as well as the presence of ionic contaminants or a salt water intrusion. MIP Technology has been deployed on a number of sites for DNAPL delineation and characterization. The technology demonstrated very high correlation with analytical results and provided significant cost savings by providing real-time information used for the optimization of the ground-water sampling program. Improvements to the design of the MIP equipment have resulted in significant reduction of on-site downtime and improved overall reliability. ZEBRA Environmental Corporation has developed a set of Standard Operating Procedures, QA/QC procedures, and guidelines for the interpretation of the MIP system output. The presentation focuses on interpretation of the MIP output, analysis of the most common MIP data processing errors, integration of the MIP technology with field-portable analytical instruments, and the issues of correlation with analytical data and data repeatability.

Site Characterization with the Membrane Interface Probe
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A major challenge associated with cleanup of sites contaminated with chlorinated solvents is identifying the location or source areas of dense nonaqueous phase liquids (DNAPLs). Conventional ground-water sampling technologies rely on collection of ground-water samples either from a well screen typically at least several feet long or, more recently, from discrete-depth sampling probes such as the Waterloo Profiler. Ground-water samples collected from monitoring wells may not reveal the highly elevated solvent concentrations that often suggest the possible presence of a DNAPL. The use of discrete-depth probes, while more useful in revealing high concentration ground-water zones than conventional monitoring wells, does not provide real-time data, which can be highly beneficial to site investigators. Also, neither of these methods is useful in evaluating the presence of DNAPL in the vadose zone.

Performance Monitoring of a Permeable Reactive Barrier at the Somersworth, New Hampshire Landfill Superfund Site
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Over a six-month period, the performance of a pilot-scale PRB at the Somersworth, NH, Landfill Superfund Site was evaluated. The 21-ft long PRB was installed in November 1999 to test a construction technique that uses a biodegradable polymer slurry to support an open excavation while a granular iron/sand mixture is placed into the subsurface. Criteria used to assess the PRB's performance included (1) hydraulic testing to evaluate potential fluid viscosity effects related to the use of the biopolymer, (2) monitoring of VOCs, ground-water parameters (pH, DO, ORP, specific conductance), and inorganic parameters, including metals, major ions, and nutrients, (3) microbial characterization of ground water, (4) reactivity testing of emplaced iron material, and (5) advanced surface analysis of cored iron material. Dedicated, in-well ground-water quality probes (YSI-600 XLM) also were deployed in four wells set along a transect through the PRB to collect data that would correlate measured ground-water parameters with changes in barrier performance (e.g., biopolymer breakdown and inorganic precipitation).

Radiofrequency Sensor Network for Monitoring Containment Integrity
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Rugged, low-cost sensors are needed to monitor the integrity of the engineered covers over both the short and long term. This paper describes a network of radio frequency (RF) sensors, coated with a corrosion protective layer, for monitoring the migration of contaminant plumes. Input impedance of the network will vary with frequency and the dielectric properties of the soil medium, including that of contaminant plumes leached out of capped sites. The network is much like a telephone cable buried around the containment boundary, and the sensors are interrogated from one end of the cable. The system is passive in that the line is not powered all of the time and provides measurements only on demand. As a result, it is a simple, inexpensive, and rugged network for monitoring the integrity of engineered covers over a long period. Preliminary tests at 100, 500, and 1000 MHz of an open-ended coaxial probe buried in a sand box showed good sensitivity to chemical contaminants.

Deployment of an Alternative Closure Cover and Monitoring System at the Mixed Waste Disposal Unit U-3ax/bl at the Nevada Test Site
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Final closure of the Mixed Waste Disposal Unit U-3ax/bl at the Nevada Test Site was achieved by the successful deployment of RCRA alternative cover design. This closure is unique in that regulators approved a mono-layer closure cover, also known as an evapotranspiration (ET) cover, consisting of native alluvium, instead of a traditional RCRA multilayered cover. Recent studies indicate that in the arid southwestern United States, mono-layer covers may be more effective at isolating waste than layered covers because of the tendency of layered systems to fail over time. Approval of the design was contingent on the installation of soil water content sensors within the cover to monitor performance during the post-closure monitoring period. A lysimeter facility was installed immediately adjacent to the disposal unit to provide data for a detailed evaluation of closure cover performance and numerical modeling.

Locating DNAPLs with Flexible Liners

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There are two flexible liner methods for mapping DNAPLs in the subsurface. The first is a color-reactive liner emplaced via CPT Geoprobe, core, or driver casing holes in the vadose zone and saturated zone. The result is a bright stain wherever the reactive covering contacts free product. This paper describes the technique and summarizes the results at several sites. New installation methods are explained. The second flexible liner method is well suited to mapping the distribution of dissolved contaminants, including DNAPLs. This method provides multilevel sampling of pore fluids with excellent isolation of the sampling intervals. The normal installation ranges from 3-20 sampling ports in the same hole. Sampling depths of 900 feet have been done with plans to sample at 2000-5000 feet. The technique has been used in 14 states plus Ontario. Both the vadose zone and the saturated zone can be sampled with a single liner. This paper provides a progress report on a liner method for the continuous vertical mapping of the horizontal conductivity from a borehole.

A Comparison of Field Techniques for Confirming Dense Non-Aqueous Phase Liquids (DNAPLs)

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A field study was recently performed comparing several approaches to characterization of dense nonaqueous phase liquids (DNAPLs) at a site where anecdotal as well as limited direct evidence of DNAPL exists. Engineers evaluated a three-dimensional (3-D) high resolution seismic survey, field screening of soil cores with a flame ionization detector/organic vapor analyzer (FID/OVA), hydrophobic dye (Sudan IV)-impregnated reactive Flexible Liner Underground Technologies (Flute®) liner material used in combination with Rotasonic drill cores, centrifuged soil with Sudan IV dye, ultraviolet light (UV) fluorescence, a Geoprobe® Membrane Interface Probe (MIP®), and phase equilibrium partitioning evaluations based on laboratory analysis of soil samples. Sonic drilling provided reliable continuous cores from which minor soil structures could be evaluated and screened with an OVA. The OVA screening provided reliable preliminary data for identifying likely DNAPL zones and for selecting samples for further analyses. The Flute® liner material provided the primary direct evidence for the presence of DNAPL and reliable information regarding the thickness and nature of its occurrence (i.e., pooled, ganglia, etc.). The MIP® probe provided good information regarding the subsurface lithology and rapid identification and delineation of probable free-product areas. The 3-D

seismic survey was of minimal benefit to this study, and the centrifuging of samples with Sudan IV dye and the use of UV fluorescence provided no benefit. Results of phase equilibrium partitioning concentration calculations for soil samples (to infer the presence of DNAPL) were in good agreement with the site screening data. Screening data compared well with previous ground-water data and supported using 1% of the pure phase solubility limit of Freon 113 (i.e., 2 mg/L) as an initial means to define the DNAPL study area. Based on the results, the most effective approach for identifying and delineating DNAPL in the subsurface is to initially evaluate the study area with the MIP® device to identify areas and lithologic zones where DNAPL may have accumulated. Core samples (either Rotasonic or Geoprobe®) would then be collected from zones where MIP® readings were indicative of the presence of DNAPL. Soil samples from the free-product portions of the core(s) would then be submitted to a laboratory for positive analyte identification. Soil analyses would then be combined with site-specific geotechnical information (i.e., fraction organic carbon, soil bulk density, porosity) and equilibrium partitioning algorithms used to estimate concentrations of organic contaminants in soil samples that would indicate free product. Used in combination, the soil analysis and the MIP® records appear to provide accurate DNAPL identification and delineation.

New Ways in Detecting LNAPL Plumes in Granular Sediments Using Geophysical and Atmogeochemical Methods

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The existence of a low resistivity zone below a light nonaqueous phase liquid (LNAPL) plume represents an opportunity to estimate the extent of the plume by resistivity survey (multielectrode measurements, vertical electrodes) and ground-penetrating radar. The authors combined geophysical techniques with a soil vapor survey using new methods and instrumentation (ECOPROBE 5) for direct estimation of the extent of a hydrocarbon plume. Cone penetration tests combined with logging provided direct detection of contaminated layers in the vertical sections. The new soil vapor survey method, based on the combination of total PID and selective IR analyzers, reveals vital information about subsurface pollution and enables compensation for the influence of most of the disturbing factors. The efficiency of this approach is documented with materials from an abandoned military area in the Cretaceous region of Bohemia.

Hydraulic Pulse Interference Tests for Integrity Testing of Containment and Reactive Barrier Systems

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Hydraulic pulse interference tests involve a cyclic injection of fluid into the source well, and by high precision measurement of the pressure pulse in a neighboring well, detailed hydraulic characterization between wells can be made. The pulse interference test is highly sensitive to hydrogeological properties between the wells, and relatively insensitive to conditions outside of the wells. The time delay and attenuation of the hydraulic pulse enable the formation hydraulic properties transmissivity and storativity to be computed. The advantages of the pulse interference test are the short duration of the test, the high resolution and directional characterization data obtained, and the fact that no contaminated ground water is generated. To maximize the pulse test's resolution, a small section of the injector well is isolated by packers, and the flow rate into the source injector well is rate-controlled and constant, depending on the site hydraulic conditions. High precision pressure transducers are located in receiver wells and isolated from receiver borehole storage effects by straddle packers. Thus the pulse is basically

a point source, and borehole storage effects are eliminated from both the injector and receiver wells. The injector well is pulsed for a set time, shut in for the same time period, and then the cycle is repeated. The pulse source and receivers can be located at differing depth locations in their respective wells and a detailed image of the site's hydraulic conditions can be determined. The hydraulic pulse interference test is ideal to test the integrity of a hydraulic containment system or to determine if a permeable reactive barrier (PRB) does not impact groundwater flow. Pulse interference tests conducted pre- and post-PRB installation for integrity testing of an iron PRB constructed down to a depth of 110 feet are presented.

Quantitative Characterization of an IAS Air Plume using Geophysics
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The goal of this study was to determine whether geophysical techniques can be used to quantitatively describe the distribution of air in sparge plumes. Three geophysical techniques were evaluated in this study: electrical resistivity tomography, ground penetrating radar, and seismic refraction. The former technique employed measurement electrodes both in boreholes and on the surface, while the latter two techniques incorporated surface-only measurements. Air was injected into an uncontaminated glacial till at a depth of 3.3 meters. Geophysical measurements were collected both before sparging and during two different sparging episodes where flow rates of 143 m^3/day and 244 m^3/day were employed. Differences between the pre- and during-sparge images where then used to map the extent of the injected air.The results suggest that these techniques can be used to spatially describe the air plume.

The Use of 3D Seismic Imaging in Making Groundwater Management Decisions at Hazardous Waste Sites
Adams, M., Resolution Resources, Inc., Warrenton, VA.
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In 1994, the first 3D seismic survey over a hazardous waste site was performed at Naval Air Station North Island in California. The 3D seismic information, followed by confirmatory drilling, significantly changed the site conceptual model. The seismic image saved time and costs for characterization and remediation. A seismic survey at a NASA site and confirmatory drilling showed that free product was not present and that natural attenuation could be used. At Edwards AFB, CA, there was concern that contaminants could migrate off base. The seismic image demonstrated that this was unlikely. The technology can be used to help determine if ground-water problems exist and save time in remediation projects.

Automating the Monitoring Process
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Automating the monitoring process significantly reduces the cost of long-term monitoring by eliminating manual procedures required by current protocols. Burge Environmental designs and fabricates innovative automated ground-water sampling/analysis systems. One system incorporates a trichloroethene (TCE)-specific sensor (optrode) in a multi-level sampling system. This in situ system is capable of analyzing 2 ppb TCE in ground water from four separate sampling points. A three-step

calibration module calibrates the optrode. The module interrogates the monitor to insure quality data. The self-contained, solar-powered monitoring system was tested in 2000, at the former Homestead Air Force Base, FL.

Characterizing Vadose Zone Heterogeneities at Scales Controlling Contaminant Transport using Pneulog®
Stewart, L.D., Praxis Environmental Technologies, Inc., Burlingame, CA.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 99, 2001

A technology known as PneuLog® utilizes in-well instrumentation to continuously measure air permeability and contaminant concentrations on the scale of centimeters along well screens during vapor extraction in the vadose zone. Preferential flow paths produced by soil heterogeneities are clearly observed allowing the quantification of mass transfer coefficients. Correlating PneuLog® data from a representative number of wells and utilizing historical SVE data allow 3D estimates for contaminant and permeability distributions and mass transfer between adjacent soil layers. This detailed data set yields a more realistic conceptual site model than conventional characterization data. The result helps to optimize implementation of SVE by focusing remediation on source areas and accurately forecasting performance. The improved conceptual site model also generates more realistic transport modeling for setting risk-based clean up goals. For instance, the technique easily identifies low permeability materials with high moisture contents often missed in geologic logs. Such intervals pose a tremendous barrier to vaporous diffusion and are rarely included in conventional modeling, despite their dominant impact on transport. Case studies illustrate these concepts.

Rapid Characterization and Removal of Hazardous Gas Cylinders
Raunig, D.E.; D.F. Gianotto, INEEL, Idaho Falls, ID.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 107, 2001

A combination of INEEL-developed field instrumentation was used to characterize a CERCLA site containing buried gas cylinders suspected of containing anhydrous hydrofluoric acid (HF). Remedial action was accelerated due to increased risk posed by wildfires and the site's proximity to a facility with more than 1,000 occupants. The fast, accurate characterization obtained using the rapid geophysical surveyor (RGS) and portable ionization neutron spectrometer (PINS) made possible a safe, successful, cost-effective, and quick remediation of this acutely hazardous site. The RGS is a high-resolution wheeled magnetometer that collects and stores closely spaced magnetic field data. Data stored on the RGS were downloaded to produce maps indicating the spatial distribution and extent of the buried gas cylinders. The PINS assesses the chemical contents of an enclosed cylinder using gamma radiation and a spectrometer. The relative ratio of the elements clearly identifies the specific chemical compounds in the cylinder. The PINS instrumentation confirmed the presence of HF. Once located, the cylinders were hand-excavated, ultrasonically examined, and remotely handled. The valves were tested using a manifold system purged with argon gas. Cylinders were then depressurized, sampled for HF, removed, and readied for safe disposal at an approved facility.

Real-Time Vadose Zone Monitoring Capability For Performance Assessment of the Corrective Action Management Unit Containment Cell at Sandia National Laboratories, New Mexico
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2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 110, 2001

Sandia National Laboratories in Albuquerque, NM, operates a Corrective Action Management Unit (CAMU) for DOE. The CAMU containment cell will permanently store up to approximately 1,000,000 cubic feet of treated soil. The cell is situated in the desert southwest 500 ft above ground water in a region with low infiltration. These site conditions required a unique approach to monitoring cell integrity and protection of ground water. To meet RCRA ground-water monitoring requirements, a vadose zone leak detection system was incorporated into the cell design. This system utilizes the cell subliner to focus potential leakage to five longitudinal trenches filled with a wicking material surrounding vitrified clay piping. The piping provides access for neutron probes to measure soil moisture content directly under the containment cell. This system, referred to as the Primary Subliner monitoring subsystem (PSL) is capable identifying leakage quantities as small as 600 gallons. An additional moisture monitoring subsystem, the Vertical Sensor Array, consisting of 22 time-domain reflectometers, provides a backup to the PSL. These two vadose zone monitoring systems allow for real-time leak detection and long-term assessment and assurance of containment cell performance.

Cost Efficient Long-Term Monitoring (LTM) of Chlorinated VOC Plumes through the Utilization of Passive Diffusion Samplers

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2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 114, 2001

The 45th Space Wing Installation Restoration Program (IRP) office conducted a pilot test of passive diffusion samplers at two sites at Cape Canaveral Air Force Station (CCAFS) in October 2000. The pilot test was conducted to compare sample analytical results obtained through the use of passive diffusion samplers with the analytical results of samples collected using low-flow purge sampling methods. The purpose of the pilot test was to determine whether the use of passive diffusion samplers for long-term monitoring of volatile organic compounds (VOCs) in ground water would provide viable data at a cost saving to the Air Force. The passive diffusion samplers, which consist of sampler bags constructed of a semi-permeable membrane filled with analyte-free water, were tested at two abandoned launch complexes at CCAFS, Space Launch Complex 11. Both sites are being monitored under the 45th Space Wing IRP office s LTM program for dissolved chlorinated VOCs. The pilot test was conducted by installing the passive samplers in ground-water monitoring wells and allowing sufficient time for the VOCs in the ground water to diffuse into the sampler bags (a minimum of two weeks). After a four-week period had passed, the sampler bags were retrieved from the wells, and the water in the bags were transferred to glass vials. Immediately following collection of passive diffusion samples, the wells were sampled using program-approved low-flow purge methods. The two sets of samples were submitted to an analytical laboratory for VOC analysis by SW8260. A comparison of the analytical results for indicates that, in general, the results of the diffusion samplers correspond with the results of samples collected using low-flow purge sampling methods. A comparison of the effort and costs associated with each method indicates that the use of passive diffusion sampling methods can be conducted at 60% of the cost of sampling using low-flow purge sampling methods, representing a 40% cost saving. The 45th Space Wing IRP office has recommended to the U.S. EPA and Florida DEP that passive diffusion samplers be used for conducting long-term monitoring of VOCs in ground water at CCAFS.

Waste Pit Imaging at the Idaho National Engineering and Environmental Laboratory using the Very Early Time Electromagnetic (VETEM) System

Wright, D.L. (U.S. Geological Survey, Denver, CO); J.D. Abraham; D.V. Smith; S.R. Hutton.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 117, 2001

The Very Early Time Electromagnetic (VETEM) system, developed with support from DOE's Environmental Management Science Program, was deployed at Pits 4, 9, and 10 in the Subsurface Disposal Area of the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory. Monitoring well data indicated that contaminants were migrating from these pits. Remediation was planned in portions of the pits to mitigate contaminant migration. VETEM provided geophysical images of the location and estimated depths of some of the metal waste in Pit 9. The images were used as a guide to position stainless steel probe tubes for nuclear logging, which were necessary to definitively locate and identify radionuclides in the waste. VETEM is designed to produce high-resolution images of the shallow subsurface when the electrical conductivity is too high for ground-penetrating radar (GPR) to be effective, such as in the clay capping material over the waste pits. The University of Illinois developed an inversion algorithm appropriate to VETEM data that was used to provide depth estimates to highly conducting objects in Pit 9. Subsequently, data were collected over the approximately 41,000 m^2 of Pits 4 and 10. The data from Pits 4 and 10 are of high quality and were the first to be produced using a new version of VETEM towed by an all-terrain vehicle with an integrated real-time kinematic global positioning system that can provide decimeter-level positional accuracy. The high-resolution time-slice images of Pits 4 and 10 reveal lateral location of buried waste and of conductivity variations in the subsurface.

Accurate Assessment of Natural Attenuation using Depth Discrete Multi-Level Monitoring: Evidence at Three Chlorinated Solvent Sites
Guilbeault, M.A. (Univ. of Waterloo, Waterloo, Ontario, Canada); B.L. Parker; J.A. Cherry.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 120, 2001

Releases of PCE and TCE decades ago at three industrial sites in Florida, New Hampshire, and Ontario formed suspended DNAPL source zones and dissolved phase plumes within sandy aquifers. Detailed multi-level monitoring of ground-water concentrations along transects orthogonal to flow was performed at all three sites to examine natural attenuation processes. The Waterloo Profiler and permanently installed multi-level bundle samplers were driven by an Enviro-Core direct-push rig at more than 70 locations and used at a vertical spacing as close as 15 cm to determine peak concentrations within the source areas and downgradient dissolved phase plumes, where conventional monitoring wells had underestimated peak concentrations and even the location of the plume. Continuous cores used to determine stratigraphy and concentration profiles showed that the maximum concentration peaks along vertical profiles were extremely sharp and varied a maximum of 4.5 orders of magnitude over a vertical interval as small as 30 cm. The high resolution sampling showed that 90% of the mass discharge occurs within less than 20% of the transect cross-sectional area at each site. All three sites showed strong attenuation of peak concentrations from solubility to less than 15% (Ontario), 10% (New Hampshire), and 1% (Florida) of solubility within 10 m, 5 m, and 30 m, respectively. Dispersion was the dominant attenuation mechanism at all three sites and degradation accounted for considerable attenuation at the Florida site.

Source Characterization of a DNAPL Site using Multiple Assessment Techniques
Nocita, B.W. (HSW Engineering, Inc., Tampa, FL); C.D. Henry; J.P. Caballero; T.W. Griffin.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 124, 2001

Multiple assessment techniques at a chlorinated solvent site in north-central Florida helped to define the horizontal and vertical extent of DNAPL in the subsurface. Two technological approaches were tried for the source-area characterization: one used the membrane interface probe and direct push (GeoProbe®) and Rotasonic® core samples with an onsite laboratory conducting standard gas chromatograph analyses; the other used the Waterloo® piston cores with methanol preservation of soil samples collected from small, discrete intervals. Subsamples from the piston cores were evaluated in the field with the Sudan IV® dye to indicate the presence or absence of DNAPL. Soil samples also were analyzed by an onsite mobile laboratory to compare results with the Waterloo® analytical results. Additional physical and geotechnical data were collected concurrently with the assessment data to aid in evaluating the feasibility and/or the potential performance of several remedial options, including excavation, chemical oxidation, six-phase heating, three-phase heating, and dynamic underground stripping. The results of the MIP/GeoProbe® investigation yielded similar analytical results as the Waterloo® investigation. The direct push methods utilized in both approaches produced very little investigative waste and generally collected more and better cores per day than traditional drilling methods with split spoon sampling.

New Method & Instrumentation for the In Situ Soil Contamination Survey
Blaha, G.; L. Kouklik, RS DYNAMICS Ltd., Prague, Czech Republic.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 132, 2001

A new soil vapor survey method based on the combination of total PID and selective infrared analyzers reveals vital information about subsurface pollution. Simultaneous measurement of total soil gas/vapor concentration (PID) together with infrared selective analyses for methane, carbon dioxide, and petroleum hydrocarbons, complemented by oxygen, soil temperature, and pressure data brings in situ correlation graphs that give complete information about subsurface location and/or migration of the contaminant plume. Correlation among individual measured values and the interpretation of the simultaneous in situ data are explained and discussed.

Measurement of the Aerosol Size Distribution and Its Implications for Dose Calculations
Leifer, R. (U.S. DOE, New York, NY); E.M. Jacob; S.F. Marschke; D.M. Pranitis; H.R.K. Jaw.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 132, 2001

A rotating drum impactor was co-located with a high volume air sampler for ~1 year at the fenceline of DOE's Fernald Environmental Management Project site. Data on the size distribution of uranium- and thorium-bearing atmospheric aerosols were obtained and used to compute dose using several different models. During most of the year, the mass of U-238 above 4.3 μm exceeded 80% of the total uranium mass from all particulates. During any sampling period the size distribution was bimodal. Thorium concentrations were comparable to the uranium concentrations during the late spring and summer period and decreased to ~25%of the U-238 concentration in the late summer. The seasonal average of the Activity Medium Aerosol Diameter, based on the impactor data, was approximately 6.5 μm. The current calculation method used to demonstrate compliance with regulations assumes that the airborne particulates are characterized by an activity median diameter of 1 μm, which assumption results in an over-estimate of the dose to offsite receptors by as much as a factor of seven relative to values derived using the latest ICRP 66 lung model with more appropriate particle sizes. Further evaluation of the size distribution for each radionuclide would substantially improve the dose estimates.

Detecting Free Phase Product Outside of Polyvinyl Chloride (PVC) Well Casings

Kwader, T. (URS Corp., Tallahassee, FL); P.G. Benson (Advanced Borehole Services, Tampa, FL).
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 138, 2001

Borehole conductivity probes have been used to identify bulk formation resistivity changes in uncased and non-metallic cased holes for nearly two decades. Advances in microelectronics have made it possible to build borehole conductivity probes of much smaller diameter, allowing the probes to be run in the type of 2-inch PVC wells that are widely used to monitor environmental conditions at contaminated sites. The presence of significant quantities of high-resistivity light nonaqueous phase liquid (LNAPL) hydrocarbons (motor fuels) measurably impacts the bulk resistivity, and in most cases, can be easily identified outside of the borehole. The transmitter-receiver spacing can be configured to "null" signals inside and near the borehole, neglecting the influence of borehole fluids, casing, and sand pack, and to measure the bulk resistivity of the formation 12 to 36 inches from the borehole. Stratified floating product LNAPL can easily be identified throughout the borehole, including product perched on clay layers above the water table, outside the borehole, if present. In one study involving an old petroleum refinery, more than 70 boreholes were logged with the conductivity probe to evaluate its effectiveness in detecting free product thickness outside of PVC casings. The data from the borehole geophysical logs were confirmed with adjacent borehole drilling data (Shelby tubes) and in situ fluorometric data from a probe designed to detect subsurface hydrocarbons. A comparison between the various methods of detecting LNAPLs indicated that correlation of the conductivity with probe data and the presence of LNAPLs were in good agreement.

Deployment Issues for Sensors for Long-Term Monitoring Applications
Hale, D.L. (INEEL, Idaho Falls, ID); T.R. Smail (Westinghouse Savannah River Co., Aiken, SC).
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 144, 2001

Low cost, robust sensors are needed for remote, in situ monitoring of contaminants, verification of cleanup remedies, or other indicators of potential stewardship failures in a variety of media. Sensing targets include contaminants (organics, metals, radionuclides), diagnostic parameters (dissolved oxygen, etc.), water quality indicators (salinity, pH, Eh, oxidation-reduction potential, etc.), soil characteristics (dielectric constant, matric potential, moisture content, erosion, etc.), meteorology and climatic variables, and radiation levels. Some commercially available sensors can meet the general functional requirements for sensing these parameters in soil or groundwater. However, site-specific constraints, such as the size of a borehole or depth to the water table, are the chief obstacles to the deployment of existing sensors. Harsh operating conditions, variable contaminant levels, mixtures, and distributions present challenges for the deployment and operation of sensors for long-term monitoring applications. This paper discusses deployment issues, such as methods to emplace sensors, integration of a suite of sensors, electronics and communications interfaces, construction of modular monitoring networks, and telemetry of sensor output to a centrally located processing station.

Geochemical Investigation of Three Permeable Reactive Barriers to Assess Impact of Precipitation on Performance and Longevity
Sass, B. (Battelle Memorial Inst., Columbus, OH), A. Gavaskar, W-S. Yoon, N. Gupta, E. Drescher; C. Reeter (U.S. Navy, Port Hueneme, CA).
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 147, 2001

A geochemical assessment is under way at three permeable reactive barrier sites to evaluate performance and longevity issues. The assessment is being carried out at former NAS Moffett Field

(CA), Dover AFB (DE), and former Lowry AFB (CO). These sites were selected because they differ in barrier design, contaminant types, hydrology, and geochemistry, and therefore represent a number of factors that could have bearing on long-term performance. Analysis of ground water and iron cores were the primary means used to evaluate the potential for precipitate formation, which could affect both the surface reactivity of the iron as well as the hydraulic conductivity of the reactive cell. In addition, geochemical modeling with PHREEQC and Geochemist's Workbench was used to simulate iron reactivity in each of the three ground-water types and assist in understanding precipitation sequences.The study focused on behavior of native inorganic constituents of the ground waters, such as dissolved oxygen, calcium, magnesium, alkalinity, and sulfate, as potentially able to influence precipitation within the reactive cells. In addition, long-term accelerated column tests are currently underway using two different iron-groundwater systems, which model the Moffett Field and Lowry barriers. Results of the column tests will assist in understanding precipitation kinetics and physicochemical characteristics.

Demonstration of Geostatistical Methods for Long-Term Groundwater Monitoring Optimization
Yager, K. (U.S. EPA, Edison, NJ); T. Lillys (Hydrogeologic, Inc., Herndon, VA), P. Sullivan.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 152, 2001

The U.S. EPA Technology Innovation Office is sponsoring a project to showcase the use of geostatistics as a tool to evaluate and optimize long-term ground-water monitoring activities. During this project, geostatistics and other techniques will be used to evaluate spatial and temporal frequency of monitoring data with respect to data quality objectives. The objectives of this demonstration are to (1) increase the awareness of geostatistical methods and their specific application to long-term monitoring optimization (LTMO); (2) determine the usefulness of geostatistical methods for LTMO problems; (3) determine the applicability of geostatistical methods for LTMO problems; and (4) promote the use of these techniques for LTMO problems. One of the benefits of geostatistics is they can provide both regulators and responsible parties a more quantitative analysis of when and where to collect ground-water samples. To this end, four sites with existing long-term ground-water monitoring networks will be included in the study. Assistance will be provided to each site to determine if suggested modifications to the monitoring networks are feasible and acceptable from a regulatory standpoint. Preliminary results from up to three of the sites are discussed. In addition to the geostatistical evaluation, a new software product for long-term monitoring design and evaluation—MAROS—developed for the Air Force Center for Environmental Excellence, will be used to perform parallel evaluations at the same four sites.

Hyperspectral Remote Sensing of SRS Capping Systems
Gladden, J.B. (Westinghouse Savannah River Co., Aiken, SC); A.M. Filippi (Univ. of South Carolina, Columbia), J.R. Jensen; D.J. Kelch (MTL Systems, Inc., Dayton, OH); M.G. Serrato (Westinghouse Savannah River Co., Aiken, SC); M.M. Pendergast (SMP Enterprises, Martinez, GA).
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 153, 2001

Aerial remote sensing was conducted over the SRS Mixed Waste Management Facility and the Low Level Radioactive Waste Disposal Facility using the AVIRIS hyperspectral sensor system deployed by NASA. This sensor system provides data across a wide portion of the spectrum with very narrow band widths. Data were processed using a variety of traditional and innovative techniques to analyze the spectral signatures derived from the vegetative cover at these two facilities. Limited ground truth data were available for correlation with the remote sensing data, but substantial differences were evident across the caps. Numerous algorithms derived from the agricultural sciences proved useful in analyzing the data, as did several more novel approaches. Qualitatively, the analyses correlated with spatial

differences in grass species composition, apparent vegetation density, and other cap management attributes. Spectra derived from copper-stressed bahia grass were also useful in analyzing the hyperspectral data, suggesting a more generic spectral response to stressors. Statistically significant correlations were obtained between certain spectral groupings and subsidence measurements on the two caps. These results indicate a significant potential for using aerial remote sensing data for monitoring the quality of the vegetative layer and possibly other parameters related to capping system functional performance.

Networked Emplantable Sensors and Web-Based Data Acquisition for Long-Term Environmental Monitoring
Haas, J.W.; S.P. Farrington, Applied Research Associates, Inc., S. Royalton, VT.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 158, 2001

The authors describe sensor packages that can be permanently emplaced in the subsurface using direct push technology. A microcontroller embedded in each package digitizes sensor output and communicates with a field computer via an RS-485 connection. Sensor identification and calibration information also are stored on EEPROM in the embedded system. Sensors deployed to date include pH, ORP, and temperature for water quality monitoring, and volumetric soil moisture, soil electrical conductivity, and temperature for vadose zone soil monitoring. Additional sensors are under development. The field communications protocol will accommodate over 3000 sensors per network, and wireless linking between field components and from the field network to the Internet is also possible. The field computer can store acquired data locally or transmit them via any TCP/IP connection to an Internet-accessible host computer running WebDACS™. WebDACS™ is Applied Research Associates' web-based data acquisition and control system. This system makes monitoring data available to users through the interface or any standard web browser. Users can access their data from virtually anywhere they can connect to the Internet. WebDACS™ generates on-screen plots and tabular output, as well as downloadable ASCII files, and provides data security features that include password protection and visibility control.

Optimization of Phytoremediation Process by Monitoring Plant Fluorescence
Richter, P.I., Technical Univ. of Budapest, Budapest, Hungary.
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 160, 2001

To enhance metal accumulation by plants and increase the rate of phytoextraction, a chelator (in this case, EDTA) is added to the soil to mobilize bound metals, thus making them more available for uptake by plants and dramatically increasing the rate of uptake. Monitoring the temporal variation of plant fluorescence provides a measure of the plants' health status, before any stress-related damage to the plants appears. A computerized, portable chlorophyll fluorometer, CFM-636973, was used for optimization of the phytoremediation process. At high EDTA concentrations, the uptake is rapid but is quickly saturated, and plants die as they reach their tolerance threshold. By reducing the concentration of EDTA, the uptake will be slower, but plants will be able to invoke tolerance mechanisms that allow them to adapt to stressful environments. This mechanism can be exploited by increasing the tolerance threshold, such that the final accumulation can be increased by a factor of 3 to 5, significantly reducing total cleanup time and cost. Studies of a similar optimization for the phytoremoval of chlorinated solvents is under way.

Strip Test as a Method for Optimizing Land Characterization for Phytoremediation of Heavy Metals

Sas-Nowosielska, A. (Inst. for Ecology of Industrial Areas, Katowice, Poland), R. Kucharski, M. Korcz; S.M. Dushenkov (Florida State Univ., Tallahassee, FL), J.M. Kuperberg; E. Malkowski (Univ. of Silesia, Katowice, Poland).
2001 International Containment & Remediation Technology Conference & Exhibition, 10-13 June 2001, Orlando, Florida. Conference Program Abstracts. University of Florida, Tallahassee. p 164, 2001

Site characterization and treatability studies currently are conducted sequentially, prior to the initiation of soil phytoextraction processes. The purpose of these activities is to describe the nature and extent of contamination at the target site (site characterization), and to determine if and under what conditions proposed plant species will extract the target contaminants (treatability study). This approach is time consuming, expensive, and may not lead to success at field scale phytoextraction. A new approach, the "Strip Test," integrates site characterization and treatability studies into a single effort. The concept of the Strip Test is based on a geostatistical assumption that an adequately distributed number of soil samples can describe the distribution of metals across an investigated site. Furthermore, it is supposed that planting with the same pattern would provide information on whether the soil would support plant growth, and an estimate of phytoextraction efficiency for the site. Test results indicate that the Strip Test can be used as a method for optimizing phytoextraction.

Technology Assessment Report: SimulProbe®, SimulProbe Technologies, Inc.
[Multiphasic Sampling Probe for Underground Storage Tank Monitoring]
Winkler, Eric, Univ. of Massachusetts, Amherst.
The Massachusetts Strategic Envirotechnology Partnership (STEP). 47 pp, Aug 1999

The SimulProbe® is a simulphasic sample collection device. The product is capable of sampling intact volumes of unconsolidated to semi-consolidated earth and soil atmosphere or unconsolidated to semi-consolidated earth and soil water from proximate locations at the same time. The SimulProbe® is operated in the downhole end of a borehole drilled with most conventional drilling apparatus. The product is lowered to the bottom of the hole by wire line, conventional rods, or direct push rods, and driven into the soil with a hammer device. The device may not be suitable for use in soil containing gravel, cobbles, or other large, coarse fragments. SimulProbe® is unusual in its multiphasic capability and compatibility with multiple drilling methodologies.
http://www.stepsite.org/progress/reports/

Geotechnical Site Characterization: Proceedings of the First International Conference, 19-22 April 1998, Atlanta, Georgia.
Robertson, P.K.; P.W. Mayne (eds).
A.A. Balkema, Rotterdam. 2 vols., 1496 pp, 1998

Both volumes have many papers on direct push methods that are not specific to mine waste work, though they can be applied to it.

Overviews on Using Geophysics for Mine Waste Applications
Blowes, D.W.
The Environmental Effects of Mine Wastes, A.G. Gubins, ed.
Proceedings of Exploration '97, Fourth Decennial International Conference on Mineral Exploration: Prospectors and Developers Association of Canada, Toronto, ON, p 887-892, 1997

This paper provides a useful overview of geochemical, mineralogical, and hydrological processes in mine waste piles. It includes a minor geophysics discussion.

Case Histories Using Geophysics to Trace AMD Plumes
Benson, A.K.
Integrating Hydrogeology, Geochemistry, and Geophysics to Map Acid Mine Drainage: in Schultz and Sidhartan, eds., Proceedings of the 33rd Symposium on Engineering Geology and Engineering Technology, March 25-27, 1998, Reno, Nevada.
Exploration and Mining Geology, Vol 4, p 411-419, 1998

This paper summarizes the geochemistry of mine waters over an area with many mines. It includes an example in which many direct current (DC) Wenner soundings scattered throughout an area mapped out a plume.

Detecting the Presence of Acid Mine Drainage Using Hydrogeological, Geochemical, and Geophysical Data: Applications to Contrasting Conditions at Mine Sites in Little Cottonwood and American Fork Canyons, Utah
Benson, A.K.; C.L. Addams.
Environmental Geosciences, Vol 5 No 1, p 17-27, 1998

This paper summarizes the geochemistry of mine waters over an area with many mines. It includes an example in which many direct current (DC) resistivity Wenner soundings scattered throughout an area mapped out a plume, plus a second example of characterization using areal DC soundings.

Minesite Groundwater Contamination Mapping
Buselli, G.; H.S. Hwang; K. Lu.
Exploration Geophysics, Vol 29, p 296-300, 1998

This paper compares direct current (DC) resistivity and time-domain electromagnetic (TEM) methods in a study of a tailings pond, now mostly filled, at an abandoned pyrite mine in South Australia. The authors conclude that DC works best for shallow investigations, TEM for deeper ones. The text also reports on spontaneous potential (SP) work done on the property.

Development of Waste Rock Sampling Protocol Using Induced Polarization
Wardlaw, S.; R. Wagner.
CANMET-MSL Div., Nat. Resour. Can., Ottawa, LR, 777-071, 1994
An induced polarization (IP) survey of a tailings/rock pile near Sudbury, Ontario, successfully identified high sulfide concentrations therein. The authors propose that IP work could be part of protocols to estimate the sulfide contents of such sites.

The Development of Enzyme-Linked Immunosorbent Assays for the Detection of the Herbicides Glyphosate and Dicamba in Water
Clegg, Benjamin Stephen, thesis (Ph.D.), University of Guelph (Canada).
University Microfilm, Inc., Ann Arbor, MI. UMI Pub No: AAT NQ67228, ISBN: 0-612-67228-X, 160 pp, 2002

A competitive indirect enzyme-linked immunosorbent assay (CI-ELISA) was developed to quantitate the herbicide glyphosate (*N*-(phosphonomethyl) glycine) in water. The CI-ELISA had a detection limit of 7.6 ug/mL^{-1} and a linear working range of 10 to 1,000 ug/mL^{-1} with an IC_{50} value of 154 ug/mL^{-1}. The glyphosate polyclonal antisera did not cross-react with a number of other herbicides but did cross-react

with the glyphosate metabolite, AMPA (aminomethylphosphonic acid) and a structurally related herbicide glyphosine ((*N,N* bis-phosphonomethyl) glycine). The assay was used to estimate, quantitatively with accuracy and precision, glyphosate concentrations in water samples. Water samples were analyzed directly and no sample preparation was required. To improve detection limits, water samples were concentrated prior to analysis resulting in a 100-fold increase of the detection limits. After the sample pre-concentration step, the detection limit improved to 0.076 ug/mL^{-1} with an IC_{50} value of 1.54 ug/mL^{-1} and a linear working range of 0.1 to 10 ug/mL^{-1}. Glyphosate concentrations determined by CI-ELISA correlated well with those determined by high pressure liquid chromatography (HPLC). The slope of the line was 1.4 with an $r^2 = 0.99$. A competitive indirect enzyme-linked immunosorbent assay (CI-ELISA) was developed to quantitate the herbicide dicamba (3,6 dichloro-2-methoxybenzoic acid) in water. The CI-ELISA had a detection limit of 2.3 ug/mL^{-1} and a linear working range of ~10,000 ug/mL^{-1} with an IC_{50} value of 195 ug/mL^{-1}. The dicamba polyclonal antisera did not cross-react with a number of other herbicides but did cross-react with a dicamba metabolite, 5-hydroxydicamba, and structurally related chlorobenzoic acids. The assay was used to estimate quantitatively with accuracy and precision, dicamba concentrations in water samples. Water samples were analyzed directly, and no sample preparation was required. To improve detection limits, a C_{18} (reversed phase) column concentration step was devised prior to analysis and the detection limits were increased by at least 10 fold. After the sample pre-concentration the detection limit, IC_{50} and linear working ranges were 0.23, 19.5, and 1.0 to 1,000 ug/mL^{-1}, respectively. The CI-ELISA assay estimations in water correlated well with those from gas chromatography mass spectrometry analysis (GC-MS). The slope of the line was 1.33 with an $r^2 = 0.999$. Both immunoassays contribute to reducing laboratory costs associated with the conventional HPLC and GC-MS residue analysis techniques for the quantitation of glyphosate and dicamba, respectively.

Novel Laser-Based Gas Sensors for Trace Gas Detection in a Spacecraft Habitat
Leleux, Darrin Paul, thesis (Ph.D.), Rice University.
University Microfilm, Inc., Ann Arbor, MI. UMI Pub No: AAT 3047331, ISBN: 0-493-61542-3, 120 pp, 2002

The principal objective of this research has been the development of advanced data reduction techniques and their application to real-time detection and precise concentration measurement of trace gases for use in spacecraft habitats. Trace gas detection was performed using compact infrared diode laser-based absorption gas sensors. These sensors have proven to be very sensitive, selective, and rugged to permit use in spacecraft environments. The infrared laser sources take advantage of recent significant developments of new infrared nonlinear materials, progress in diode and solid state lasers, and fiber optics technology. The techniques developed in this thesis include realtime Voigt fitting, simultaneous multi-species detection, and Kalman filtering. These techniques were applied in several field campaigns, including formaldehyde monitoring in downtown Houston, Deer Park, and Channelview, TX, as well as ammonia and carbon dioxide monitoring in a Biological Wastewater Processor at the Johnson Space Center in Houston.

UV Laser Induced Fluorescence Spectroscopic Studies and Trace Detection of Dissolved Plastics (Bisphenol-A) and Organic Compounds in Water
Sivaprakasam, Vasanthi, thesis (Ph.D.), University of South Florida.
University Microfilm, Inc., Ann Arbor, MI. UMI Pub No: AAT 3052669, ISBN: 0-493-67369-5, 248 pp, 2002

Two different Laser Induced Fluorescence (LIF) systems were developed and used to measure the fluorescence spectra of trace organic compounds and plastic residue leached into water. The first LIF system, a wavelength tunable UV laboratory system, was used for spectroscopic surveys and consisted

of a nitrogen pumped, frequency-doubled, tunable (220-280 nm) UV laser system. The collected fluorescence light (300 nm to 700 nm) was analyzed by a spectrograph and cooled CCD detector array. The system was used to obtain calibration fluorescence spectra and Excitation-Emission Matrix (EEM) spectra of Bisphenol-A and various water samples containing dissolved organics. A second LIF system, a portable fixed UV-wavelength LIF system, was developed for shipborne measurements in detecting artificial and natural trace organic substances in seawater. The excitation laser was a fixed wavelength microchip laser at 266 nm and the collected fluorescence light was analyzed by optical interference filters ranging from 239 nm to 685 nm and a PMT detector. Studies were made to optimize the excitation source, collection optics, and detection process. Detailed fluorescence emission spectra due to the plastic bisphenol-A and the fluorescence standard quinine sulfate were made, along with lifetime, bleaching, and polarization measurements. The signal-to-noise ratio of the portable and the laboratory LIF systems were measured and compared to a commercial laboratory spectrofluorometer (Fluoro Max) and a portable fluorescence system (SAFire), both using Xenon light sources for excitation. The detection limit of the portable LIF system was a factor of 500 better than the commercial SAFire in terms of quinine sulfate and a factor of 50 higher than the Fluoro Max. The portable system was tested on a two-day cruise into the Gulf of Mexico to determine the instrument's sensitivity in a variety of water masses. The portable LIF system was able to measure dissolved organic compounds with a fluorescence emission near 450 nm in clean “blue” Gulf water with a sensitivity about two orders of magnitude greater than other previous measurements using the SAFire instrument.

Use of Infrared Remote Sensing for the Detection of Potential Seepage Sites along the Erie Canal (New York)
Washburn, George Robert, thesis (MS), State University of New York, College of Environmental Science & Forestry.
University Microfilm, Inc., Ann Arbor, MI. UMI Pub No: AAT 1408742, ISBN: 0-493-61408-7. 82 pp, 2002

This thesis explores the viability of using multispectral scanner data to detect and delineate potential seepage sites along the Erie Canal. Thermal and near infrared data were collected with a multispectral scanner in 29 flight lines, over three major sections covering 145 miles of the canal. Automated image classification techniques were used to separate potential seepage sites, indicated by wet areas on the ground, from other types of ground cover. The resulting classified images were registered to New York State Department of Transportation planimetric maps and loaded into a geographic information system database along with canal centerline station locations. Hardcopy maps were printed for field use. Error and accuracy matrices were computed for three of the 29 flight lines, one for each of the major sections. The results indicated the average accuracy of the three flight lines' classifications was 92.62%.

Proceedings of the Joint Conference on Point Detection for Chemical and Biological Defense (1st) Held in Williamsburg, Virginia on October 23-27, 2000
NTIS: ADA395447, 635 pp, 2000

This proceedings contains 75 unclassified papers presented at the First Joint Conference on Point Detection for Chemical and Biological Defense. The Conference was organized by the Joint Science and Technology Panel on Chemical and Biological Defense in cooperation with the U.S. Army, Navy, Air Force, and Marine Corps, and other CB Agencies. Papers appear under the following subject areas: new concepts, small detectors, optical methods for chemical detection, bioaerosol triggers, genetic assays, immunoassays, mass spectrometry and ion mobility spectrometry, improving detector performance, test and evaluation methodology, and CB sample collection and sample processing. The complete text of the proceedings is available in a PDF file through the Defense Technical Information Center (DTIC), but be warned: the file is very large and takes a long time to download.

http://handle.dtic.mil/100.2/ADA395447

Evaluating Site Remediation Success Using a Sensitive Biochemical Indicator in Fish (USGS WWRI Grant Program)
USGS Water Resources Research Institute, State Program Grant
Project No 2002KY1B
03/01/2002 through 02/28/2003
Fed. Funds Req.: $5,750/Non-Fed.: $11,645
Adria Elskus (PI), Univ. of Kentucky

Significant levels of environmental polychlorinated biphenyls (PCBs) in Kentucky have led to the posting of fish advisories in several Kentucky waterways by the Kentucky Division of Water. The focus of the present study is the Town Branch-Mud River (TB/MR) system in Kentucky, a PCB-contaminated site currently under remediation. This proposal addresses several needs identified by the Water Science and Technology Board, including the need to understand the impact of contaminants on higher organisms, to monitor the time course of recovery following contamination, and to evaluate the effectiveness of management efforts to improve water quality. The problem: Water quality in Kentucky is evaluated based on contaminant concentrations in water, sediment or biota, and/or on biological indices of species diversity. Contaminant concentrations alone provide no information on organism response, and diversity indices do not distinguish between response to contaminants, habitat disturbance, or natural stressors. For example, there is no information on whether exposure to PCBs in the TB/MR system is producing sublethal effects in fish populations in that system, and/or whether present remediation efforts are reducing those effects. The enzyme, CYP1A, is strongly and rapidly induced in animals exposed to toxic organic pollutants, including PCBs. The researcher hypothesizes thatCYP1A levels in TB/MR resident fish reflect organic contaminant levels at their site. The objectives are 1) to determine if CYP1A levels in resident fish in the TB/MR system reflect expected habitat contamination level, and 2) to use CYP1A levels in caged fish to evaluate the effectiveness of bioremediation efforts in the TB/MR system. To evaluate the response of resident fish species, the researcher will measure hepatic CYP1A expression in fish collected from reference remediated and unremediated sites in the TB/MR waterway. Species will be selected based on known sensitivity to CYP1A inducers and on our ability to collect statistically-sufficient numbers of individuals at each site to distinguish site differences in CYP1A response. Resident fish may not adequately reflect conditions at the site of capture as some species may move between remediated and unremediated areas, while others may have developed resistance to PCB induction of CYP1A. For these reasons, reference fish will be caged at each study site to provide a second site-to-site evaluation of the effectiveness of bioremediation efforts in the TB/MR system. The current cleanup efforts in the TB/MR provide an unparalleled opportunity to evaluate the effectiveness of site remediation using local populations. The results of these studies will provide insight into the response of resident and caged fish to present conditions in the TB/MR, and indicate the effectiveness of bioremediation efforts currently underway in this system. The extraordinary sensitivity, rapidity of response, and relative ease of measurement of CYP1A expression in fish makes CYP1A a promising tool for monitoring the biological effectiveness of site remediation and the time course of habitat recovery. As a monitoring tool, elevated CYP1A activity at remediated sites could indicate insufficient remediation, reintroduction of the contaminant, or introduction of new contaminants to the site, and serve as one basis for management decisions on the need for reevaluation of site contamination by more expensive methods. Additionally, elevated CYP1A levels can be used to identify hot spots or newly contaminated sites, and serve as an early warning system to alert managers to the need for remediation elsewhere in the system.

Continuous, On-Line Monitoring of Haloacetic Acids in Water Using Analytical Membrane Extraction (USGS WWRI Grant Program)

USGS Water Resources Research Institute, State Program Grant
Project No 2002NJ4B
03/01/2002 through 03/01/2003
Fed. Funds Req.: $4,000/Non-Fed.: $24,118
Dawen Kou and Somenath Mitra (Principal Investigators), New Jersey Inst. of Technology

Halogenated compounds generated by the reaction of chlorine with natural organic matter in source water have been identified in chlorinated drinking water as toxic disinfection by-products (DBPs). Health and environmental effects of haloacetic acids (HAAs) have been increasingly recognized; HAAs are toxic to humans, plants, and particularly to algae, and some are classified as carcinogens or potential carcinogens. All the existing methods for HAA analysis are only suitable for laboratory analysis of discrete samples; no instrument is available for on-line, continuous monitoring, and some of the HAAs degrade quickly and so should be analyzed as quickly as possible. On-line monitoring can provide real-time data and eliminate errors due to analyte loss and cross-contamination during sampling, sample transport, and storage. This is especially important given the instability of some HAAs. The objective of this study is to develop methods/instrumentation for automated, on-line analysis of haloacetic acids in drinking water, water resources, and wastewater, with significant saving in time, labor and money. The instruments will able to carry out continuous, real-time monitoring with high selectivity and sensitivity, and minimize the use of toxic solvents in sample preparation.

Detection of Cyanobacterial Blooms Using Remote Sensing (USGS WWRI Grant Program)
USGS Water Resources Research Institute, State Program Grant
Project ID: 2002VT5B
03/01/2002 through 02/28/2003
Fed. Funds Req.: $5,500/Non-Fed.: $12,118
Suzanne Levine (PI), Univ. of Vermont

Cyanobacterial blooms are a common nuisance in Lake Champlain and many smaller lakes throughout Vermont. Besides reducing the lakes' aesthetic appeal, these blooms adversely affect food webs and create water quality problems. Drinking water withdrawn from lakes experiencing a blue-green algal bloom may have an unpleasant taste and odor and in some cases is toxic, due to cyanobacterial production of phytotoxins. The recent death of several dogs after consumption of cyanobacterial-laden water from Lake Champlain has caused considerable concern about the State's many blooms and their potential impacts on swimmers as well as animals that drink the water. Beaches and boat access points now are posted with warning signs when blooms are present, and small eutrophic lakes with drinking water intakes are treated with copper sulfate to prevent bloom development. Lake Champlain is too large for treatment however, so Burlington and the numerous small towns that obtain drinking water from the lake must rely on filtration to reduce phytotoxin levels. Satellite remote sensing and modern image processing techniques offer the potential to aid lake managers in detecting blooms and thus in extending and refining their monitoring efforts across the state. The proposed study would begin the groundwork needed to use remote sensing for bloom detection. The goal is to obtain sufficient evidence to prepare and support a formal proposal in 2002/2003 to develop algorithms to estimate cyanobacterial density using satellite remote sensing imagery.