ELEVENTH MEASUREMENT AND MONITORING LITERATURE UPDATE

Abandoned Mine Site Characterization Using Digital Field Mapping, UV-VIS-NIR Spectroscopy, and Water Sampling: an Integrated Method
Takagi, Tina K.; George H. Brimhall, Univ. of California at Berkeley.
IAMG 2001: Annual Conference of the International Association for Mathematical Geology, 6-12 September 2001, Cancun, Mexico. 17 pp, 2001

The design and implementation of a non-invasive water sampling program to characterize the temporal variation of stream and river water quality effects of three abandoned Cu-Zn mines in the Sierra Nevada Foothills, CA, combines GIS, digital field data, and time-series chemical data. The researchers have developed a method for rapid and non-invasive mine site characterization with a digital mapping system and periodic water sampling. The method is being utilized to characterize historically mined volcanogenic massive sulfide deposits in the Sierra Nevada Foothills to determine the potential for acid generation. The mappable soluble salts that precipitate on the surface of mine waste dumps are washed down to the streams and rivers that drain these mine sites in the wet season, contributing to increased metal loading. Monthly and bimonthly water sampling and analysis by atomic absorption spectroscopy characterizes this temporal variation in water chemistry and its link to the changing surface mineralogy of the abandoned mine dumps. Design of the sampling program began with the compilation of watershed and monitoring station maps, property boundary maps, and street maps. Those data were used in combination with geologic and topographic maps to determine appropriate sampling locations. In the field, water sampling sites were located to sub-meter accuracy using a differential GPS and were mapped on a pen computer using U.C. Berkeley's GeoMapper software. Features not shown on published maps, such as intermittent or small stream drainages, old mine structures, access roads, gates, and fences were also located and mapped. The water chemistry data and field measurements, along with the published and digitally-produced field maps, provide powerful tools for determining the effect of acid mine drainage on water quality.
http://eps.berkeley.edu/groups/erc/Documents/takagi.pdf

Aboveground Leak Detection System for Bulk Fuel Tanks
Karr, Leslie (NFESC, Port Hueneme, CA); Joseph Maresca, Jr.; William Pickett.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 149, 2002

The Naval Facilities Engineering Service Center (NFESC) successfully conducted a third-party evaluation of the Low Range Differential Pressure (LRDP) leak detection system in bulk fuel aboveground storage tanks. The system was previously validated under ESTCP to meet both federal and state monthly and annual testing requirements for bulk underground fuel tanks. The ESTCP effort demonstrated and validated the performance of the LRDP in aboveground storage tanks. The evaluation was conducted on two types of tanks. The first was a floating pan, 10,000 barrel tank 54 feet in diameter and 32 feet high. The second tank was fixed roof, 150,000 barrels, 164 feet diameter and 47 feet high. The LRDP is a fully automated computer controlled leak detection system that can be permanently installed in a tank or used as a portable system. The system can be used to conduct tests of various durations (from 10 hrs to 48 hrs) depending on the type and size of tank to be tested. The tests were conducted by Ken Wilcox and Associates using a standard EPA approved protocol for bulk fuel tanks. The LRDP system is a mass-based leak detection system that is capable of meeting both annual and monthly requirements with one system. The LRDP uses a reference tube that extends vertically from the top to the bottom of the tank; has a sealed container mounted at the bottom of the reference tube which contains a differential pressure sensor that measures the difference between the level of liquid in the tank and that in the reference tube; and has temperature sensors that are mounted on the external walls of the AST that measure the diurnal temperature variations of the tank steel wall.

Advanced Electronic Tongue Concept
Buehler, M.G.; G.M. Kuhlman; D. Keymeulen; S.P. Kounaves.
2002 IEEE Aerospace Conference Proceedings, Vol 1, p 407-416, 2002

An effort directed at developing a sensor for evaluating water quality is based on electrochemical techniques that detect and identify ions in solution. This paper discusses the use of Cyclic Voltammetry (CV), corrosion measurements, and Anodic Stripping Voltammetry (ASV) to measure three marker ions--Cu, Fe, and Zn--using Electronic Tongue 1.

Advanced Passive Acoustic Leak Location and Detection Verification System for Underground Fuel Pipelines. ESTCP Cost and Performance Report
U.S. DoD, Environmental Security Technology Certification Program (ESTCP).
Report No: CP-9904, 55 pp, Apr 2003

The Pipeline Acoustic Leak-location System (PALS) was demonstrated and validated under a wide range of operational conditions. All of the objectives of the project were met, and PALS is ready for commercial use. The ESTCP project follows previous projects conducted on this technology by the Strategic Environmental Research and Development Program (SERDP) and EPA. PALS is a portable, computer-controlled, passive acoustic system where the innovation is the application of robust signal processing algorithms that allow small leaks to be located accurately over operationally practical separation distances. PALS can be retrofitted to existing fuel lines or designed into new lines. PALS consists of three cylindrical acoustic sensors, three small pre-amplifiers, and a field-worthy notebook computer containing a data acquisition card. The sensors are attached with epoxy directly to the pipe wall or to a flange connection. Each sensor measures the acoustic signal generated by the turbulent flow through a hole in the pipe. A pair of sensors brackets the leak and determines the location of the leak relative to one of the two sensors, the "reference" sensor. A second pair of sensors that do not bracket the leak measure the speed of propagation of the acoustic wave in the pipe. A leak-location measurement can take as little as 2 to 5 minutes to complete. PALS is operated using a Graphical User Interface (GUI) software package. The PALS is easy to set up and can be operated by a field technician with a minimal amount of training. PALS is best used only after a leak has been detected; it first verifies the existence of the leak and then quickly and accurately locates it. This report summarizes four sets of DEM/VALs conducted between April and October 2000 on different types and configurations of underground bulk and hydrant pipelines over a wide range of hole sizes, line pressures, leak rates, backfill conditions, and background noise conditions.
http://www.estcp.org/documents/techdocs/200305.pdf

Air Monitoring for Phosphine Using a Pulsed Flame-Photometric Detector
Macon, Sandra T.; Donald P. Segers; Craig B. Lagrone, OI Analytical, Pelham, AL.
PITTCON 2001, Abstracts, p 923, 2001

The Field MINICAMS®, manufactured by CMS Field Products, OI Analytical (Pelham, Alabama), is an automated air monitoring system capable of detecting a wide range of VOCs. Phosphine, a widely used commercial fumigant, can be detected using the Field MINICAMS equipped with a Pulsed Flame-Photometric Detector (PFPD) and a sampling inlet configured with a gas-sampling loop. This paper presents data demonstrating low, parts-per-billion detection of phosphine in air using short cycle times to provide continuous near-real-time MINICAMS monitoring for phosphine applications. The advantages of the PPFD for phosphine monitoring include high sensitivity, high selectivity to limit interferences, and low operating gas consumption.

Analysis of Environmental Pb Contamination: Comparison of LIBS Field and Laboratory Instruments
Wainner, R.T.; R.S. Harmon; A.W. Miziolek; K.L. McNesby; P.D. French.
Spectrochimica Acta Part B, Vol 56 No 6, p 777-793, 29 Jun 2001

A commercial laser-induced breakdown spectroscopy (LIBS) chemical sensor sufficiently compact and robust for field use has been developed under the sponsorship of the Army Research Office of the Army Research Laboratory. This portable unit was developed primarily for non-destructive, rapid detection of lead (Pb) in soils and in paint. A study was undertaken to compare the performance of the portable system with a laboratory LIBS system at the Army Research Laboratory that employs a much more sophisticated laser and detector. The study examined the effects on the performance of the field sensor's lower spectral resolution, lack of detector gating, and the multiple laser pulsing that occurs when using a passively Q-switched laser. Both the laboratory and portable LIBS systems exhibited similar performance with regards to detection of Pb in both soils and in paint over the 0.05 to 1% concentration levels, which suggests that for samples similar to those studied here, high-temporal resolution time gating of the detector is not necessary for quantitative analysis by LIBS. The multiple pulsing of the laser did not have a significant positive or negative effect on the measurement of Pb concentrations. No other Pb line was superior in strength to the 406-nm line for the latex paint and the type of soils used in the study, though the emission line at 220 nm in the UV portion of the spectrum holds potential for avoiding elemental interferences. The portable LIBS system was tested successfully at field sites of documented Pb contamination in California and Colorado.

Analytical Method Developments to Support Partitioning Interwell Tracer Testing
Bruce, Mark L. (Severn Trent Laboratories); Randy Parker; William Kosco; John Thompson; Greg Swanson; Allan M. Tordini; Raymond Risden; Jeffrey Smith.
PITTCON 2001, Abstracts, p 1360, 2001

Partitioning Interwell Tracer Testing (PITT) uses alcohol tracer compounds in water samples in estimating subsurface contamination from non-polar pollutants. The water samples can contain many dissolved components--salts, surfactants, and acid preservatives--that degrade GC performance if directly injected, as is common for most environmental alcohol-in-water analyses. Analysis of alcohol concentrations below the common 1-mg/L reporting limit (for direct aqueous injection) can be useful in improving PITT accuracy. EPA SW-846 Method 5031 (azeotropic distillation) has been modified using a midi-distillation system to separate the tracer alcohol analytes from potential interferences associated with acid preservatives, dissolved salts and surfactants. Recovery of tracer alcohols is generally in the 80 to 120% range. Azeotropic micro-distillation also has been extended to the high-boiling tracer alcohols to allow tracer analysis at concentrations below 0.1 mg/L. A holding time study demonstrates limited alcohol stability in unpreserved samples; samples preserved with sulfuric acid have been stable for 28 to 59 days.

Automated Detection of Chemical Vapors by Remote Multispectral Infrared Imaging Measurements
Wabomba, Mukire J.; Gary W. Small, Ohio Univ., Athens.
PITTCON 2001, Abstracts, p 1253, 2001

The authors discuss multispectral infrared (IR) remote imaging for simultaneously collecting both spatial and spectral measurements of a distant scene. The goal of this research is to develop an automated detection strategy to be used for identification of chemical vapor species in multispectral IR remote imaging data in the atmosphere for applications such as remote monitoring of chemical weapons and environmental pollution. This work utilizes data from RS-800 multispectral infrared line scanner (Raytheon TI Systems, McKinney, TX) to image and detect chemical vapor species from an airborne platform. Signal processing, image processing, and pattern recognition methods were used in an automated detection system for ammonia, ethanol, methanol, and sulfur dioxide released from a hot stack. The plume emanating from the plume generator was imaged with the line scanner system.

Automated On-Line Monitoring of VOC at the ppt Level
Amiet, Franck (Chromato-Sud, Saint-Antoine, France); Pascale Baumard.
PITTCON 2001, Abstracts, p 354, 2001

The airmOzone rack allows continuous monitoring of a wide range of ozone precursors down to ppt levels. The system uses two gas chromatographs (4U), each unit dedicated to the analysis of a specific range of compounds. The choice of adapted analytical columns makes it possible to quantify each compound from C2 to C10 individually. The sample is not prepared in any way, and the injection is split less, so the analysis of polar compounds is possible. The software controlling the system is very easy to use. Several options for air and hydrogen generators allow fully automatic operation with remote control. This paper presents the results of calibration runs and on-line field sampling.

Automated, Ultra-Trace, Remotely Controlled Analysis of VOCs in Ambient Air
JAMES G. MONCUR, John T. Whitechurch, Trace Analytical, Menlo Park, CA.
PITTCON 2001, Abstracts, p 1254, 2001

Instrumentation for automated analysis of VOCs in air can be achieved using built-in adsorption tubes and GC/FID. Concentrated air or other samples are desorbed into a capillary column system. One analyzer is designed to detect C2 to C6 VOCs using an alumina phase capillary column, while another analyzer detects C6 to C10 VOCs with a DB-624 phase capillary column. PC-based software solutions for on-site control of the gas chromatograph and data collection allows instrument access via modem or other communication protocol. Automated, continuous analysis of ambient air avoids the high cost of canister sampling methods and allows determination of air contaminants without delay. Detection of VOCs at ppb and ppt levels is permitted by adjusting the sample volume during trapping.

Biosensors for Rapid Monitoring of Primary-source Drinking Water Using Naturally Occurring Photosynthesis
Miguel Rodriguez, Jr , Charlene A. Sanders and Elias Greenbaum
Biosensors and Bioelectronics, Vol 17 Nos 10, p 843-849, Oct 2002

With primary-source freshwater drinking samples from the Clinch and Tennessee Rivers, researchers developed a tissue-based biosensor detection system that uses naturally occurring aquatic photosynthetic tissue as the sensing material for detection of chemical antagonists in the water. Sensor readout is based on well-known principles of fluorescence induction by living photosynthetic tissue. The sensor successfully detected algae in every sample examined and readily monitored changes in the characteristic fluorescence induction curves when the samples were exposed to potassium cyanide, methyl parathion, N'(3,4-dichlorophenyl)-N,N-dimethylurea, and paraquat. The unique aspect of this approach to real-time water quality monitoring is that unlike conventional sensing devices, this sensor material is external to the detecting instrument and is continuously refreshed. These biosensors can serve as continuous rapid-warning sentinels for detection of chemical warfare agents in sunlight-exposed drinking water supplies.

Capillary Electrophoretic Determination of Cyanide Leaching Solutions from Automobile Catalytic Converters
Aguilar, M.; A. Farran; V. Marti.

Journal of Chromatography A, Vol 778 No 1-2, p 397-402, 22 Aug 1997

This paper discusses the development of a capillary electrophoresis (CE) method to determine metal-cyano complexes from leaching solutions of automobile catalytic converters. The separation and detection conditions have been optimized. Analysis times up to 20 min and metal detection limits in the ppb range have been obtained. The CE analysis of leaching solutions from different converters allowed the determination of Fe, Cu, and Pd complexes and NO_3. Adsorption onto activated carbon provides a concentration process for precious metal-cyano complexes and removes pollutants. The results obtained by CE have been compared with inductively coupled plasma to validate this newly developed method.

Characterization and Mapping of Kimberlites and Related Diatremes in Utah, Colorado, and Wyoming, USA, Using the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)
Kruse, F.A; J.W. Boardman.
Proceedings of the 12th ERIM Applied Geologic Remote Sensing Conference, Boulder, Colorado, p 21-28, 1997

Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and commercially-available HyMap hyperspectral data were used to study the occurrence and mineralogical characteristics of kimberlite diatremes in the State-Line district of Colorado/Wyoming. A mosaic of five flightlines of AVIRIS data acquired during 1996 with 20-m resolution is being used to locate and characterize the kimberlite diatremes. Higher spatial resolution data are used to map additional detail. Poor exposures, vegetation cover, and weathering make identification of characteristic kimberlite minerals difficult except where exposed by mining. Minerals identified in the district using the hyperspectral data include calcite, dolomite, illite/muscovite, and serpentine (principally antigorite), but most spectral signatures are dominated by both green and dry vegetation. The goal of this work is to determine methods for characterizing subtle mineralogic changes associated with kimberlites as a guide to exploration in a variety of geologic terrains.
http://www.aigllc.com/fak/fakpubs.htm

Characterization of DNAPL using Fluorescence Techniques
Rossabi, J.; S.E. Nave, Westinghouse Savannah River Company, Aiken, SC.
Paper No: WSRC-TR-98-00125, 7 pp, 1998

There are few technologies that can successfully and consistently detect dense nonaqueous phase liquid (DNAPL) contaminants in the subsurface either directly or by inferred measurements. Because chlorinated solvents were commonly used to remove petroleum-based cutting oils and lubricants at SRS sites in degreasing operations, waste solvents can contain small amounts of the oils and lubricants. The petroleum products will fluoresce when excited by light of wavelengths capable of being transmitted over optical fiber. Samples of DNAPL from the A/M area of SRS were analyzed to assess the possibilities of contaminant detection by fluorescence spectroscopy. The DNAPL sample exhibited a strong, distinct fluorescent spectrum when exposed to an appropriate excitation wavelength. A cone penetrometer-based, laser-induced fluorescent system may be capable of providing direct detection of DNAPLs in the subsurface based on these results.
www.osti.gov/dublincore/gpo/servlets/purl/633949-li0yTN/webviewable/

Characterization of Fine Particulate Matter from Military Sources with Real-Time Instruments
Sarofim, Adel S. (Univ. of Utah, Salt Lake City); J.S. Lighty; D. Wagner; K.E. Kelly; C.F. Rogers; B. Zielinska; W.P. Arnott, J. Sagebiel; J. Schauer; K. Prather; D. Suess; G. Palmer; M. Calidonna.

Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 145, 2002

The composition of particles plays a key role in determining their health effects. For example, gasoline, diesel, and jet engines generate varying amounts of polycyclic aromatic hydrocarbons (PAHs), which are reasonably anticipated to be carcinogens. Traditionally, particle characterization has involved collecting a sufficient quantity of material on a filter and analyzing it for mass and chemical composition. This process tends to be time-consuming and expensive, and while it can provide detailed chemical speciation, it provides only limited data on transient events. As part of SERDP project CP-1106, the authors are evaluating real-time instruments for their utility in characterizing particulate emissions from military sources. The instruments include a photoelectric aerosol detector (PAS) for measuring particle-bound PAH concentrations, a photoacoustic analyzer (PA) for measuring elemental carbon concentration, and an aerosol time-of-flight mass spectrometer (ATOFMS) for measuring single-particle composition. These instruments can provide particle characterization information in situations, such as for transient events, when traditional filter tests do not perform well. They also have the potential to provide composition information quickly and more cost effectively than traditional filter measurements. The poster presents emission characterization results from three different gas turbine engines used to power military aircraft: the Turbofan TF-34-GE-400 found in S-3A, Viking anti-submarine, and KS-3A tanker aircraft; the Turboshaft T-700-GE-401 found in Seahawk, Super Cobra, and Jayhawk helicopters; and the Turbofan F404-GE F-400 found in F-18 Hornets. The authors also present ATOFMS signatures for rocket motors and results from an evaluation of catalytic diesel filters for reducing particulate emissions from military diesel engines.

The Characterization of the Kempton Mine Complex, Maryland and West Virginia, Using GIS Technology
Davis, Tamara; Constance Lyons, Maryland Department of Environment, Water Management Administration, Bureau of Mines, Frostburg MD.
Proceedings of the Annual Conference of the National Association of Abandoned Mine Land Programs (NAAMLP), 15-18 September 2002, Park City, Utah. 8 pp, 2003

In 1998, the Maryland Bureau of Mines began a comprehensive, in-depth investigation of the Kempton Mine and surrounding area to develop an accurate, detailed geologic/topographic map and technical database. Geographic Information System (GIS) technology was determined to be the best approach to store, view, and evaluate the large quantities of data and information. The Kempton GIS mapping and database includes numerous features that affect the Kempton acid mine drainage (AMD) discharges in Maryland. The Kempton GIS has proven to be an invaluable tool to evaluate alternative AMD remediation technologies. It was developed using ESRI Arcview and its extensions, Spatial Analyst and 3D. The GIS includes all data and maps collected in the study in an easily viewed format.
http://www.ogm.utah.gov/amr/naamlp/

Chemical Sensing for Buried Landmines: Fundamental Processes Influencing Trace Chemical Detection

Phelan, James M., Sandia National Lab., Albuquerque, NM.
Report No: SAND2002-0909, 90 pp, May 2002

Mine detection dogs have a demonstrated the capability to locate hidden objects by trace chemical detection. Because of this capability, demining activities frequently employ mine detection dogs to locate individual buried landmines or for area reduction. The conditions appropriate for use of mine detection dogs are only beginning to emerge through investigations that combine dog selection/training, the environmental conditions that affect landmine signature chemical vapors, and vapor sensing

performance capability and reliability. This report seeks to address the fundamental soil-chemical interactions, driven by local weather history, that influence the availability of chemical for trace chemical detection. The processes evaluated include landmine chemical emissions to the soil, chemical distribution in soils, chemical degradation in soils, and weather and chemical transport in soils. Simulation modeling is presented as a method to evaluate the complex interdependencies among these various processes and to establish conditions appropriate for trace chemical detection. Results from chemical analyses on soil samples obtained adjacent to landmines are presented and demonstrate the ultra-trace nature of these residues. Lastly, initial measurements of the vapor sensing performance of mine detection dogs demonstrate the extreme sensitivity of dogs in sensing landmine signature chemicals; however, reliability at these ultra-trace vapor concentrations still needs to be determined. Through this compilation, additional work is suggested that will fill in data gaps to improve the utility of trace chemical detection.
http://www.osti.gov/dublincore/gpo/servlets/purl/800794-nxVQDG/native/

Combined Physico-Chemical and Biological Sensing in Environmental Monitoring
Bhatia, B.; J.W. Dilleen; A. L. Atkinson; D. M. Rawson.
Biosensors and Bioelectronics, Vol 18 Nos 5-6, p 667-674, May 2003 [Selected papers from the Seventh World Congress on Biosensors, Kyoto, Japan 15-17 May 2002]

Single-use conductivity and microbial sensors were used to investigate the effect of species (chloride, nitrate, and sulphate) and concentration/osmolarity of anions on the metabolic activity of *Escherichia coli*. A new disposable, single-use conductivity sensor compatible with the CellSense™-mediated amperometric biosensor system was used to determine the effect of changing salinity and nitrate concentration on the response of *E. coli* to 3,5-dichlorophenol and mercuric chloride. This paper discusses the implications for toxicity assessment of a hybrid sensing system that allows the simultaneous monitoring of physico-chemical and biological data.

Combined Use of Laboratory and Airborne Spectrometry from the Reflective to Thermal Wavelength Range for a Quantitative Analysis of Lignite Overburden Dumps
Reinhaeckel, G.; G. Krueger.
Proceedings of the 27th International Symposium on Remote Sensing of Environment, p 507-512, 1998

The mineralogical composition of overburden dumps in the Central German Lignite Mining District was investigated using laboratory and airborne spectrometry in the wavelength region from 0.4-13 µm. Quantitative methods are presented for samples of the abandoned open pit of Espenhain which allow for the determination of quartz and kaolinite contents. Based on laboratory measurements, the approaches were applied for a spatial mapping of the parameters using hyperspectral and thermal DAIS 7915 imagery.

Continuous Sampling for Low-Level Air Monitoring Applications
Thompson, M.L. (OI Analytical, Pelham, AL); C.B. Lagrone; K.A. Kuhn; T.J. McGuire; D.P. Segers.
PITTCON 2001, Abstracts, p 925, 2001

Field MINICAMS ®, a field-portable ambient-air monitoring system manufactured by CMS Field Products, O. I. Analytical, is designed for routine monitoring of low levels of volatile and semi-volatile compounds, including chemical warfare agents and several toxic industrial compounds. When configured with optional hardware for continuous sample collection that overlaps with the gas-chromatographic analysis (instead of repetitive but non-continuous sampling-and-analysis cycles), report intervals for the compounds of interest can be decreased and gaps in sample collection eliminated. A dual-element, multiple-agent (VX, Sarin, and Mustard) monitoring method incorporating continuous sampling has been developed for the pulsed flame-photometric detector. A high volume continuous sampler (HVCS) provides for uninterrupted sampling of a specific environment, while allowing larger volumes of air to be collected for analysis. The HVCS pre-concentrator tubes are of greater diameter than those typically used with MINICAMS and allow larger volumes of air to be collected. While sample collection is taking place on one tube, the contents of the other tube are desorbed and re-focused at the MINICAMS collection tube for subsequent chromatographic analysis. The desorbed tube then is purged and cooled to be readied for the next sampling cycle. The overlapping sample-and-analysis time reduces the total cycle time/reporting interval and also eliminates any monitoring blind spots. Larger sample volumes correlate to a higher measured response and hence to better precision and accuracy.

Cyanide Determination by an ISFET-Based Peroxidase Biosensor
Volotovsky, V.; N. Kim.
Biosensors and Bioelectronics, Vol 13 No 9, p 1029-1033, Oct 1998

Horseradish peroxidase immobilized on the surface of an ion sensitive field effect transistor (ISFET) can be used for the determination of cyanide ions in aquatic media. When the enzyme is immobilized in BSA gel, the resulting sensor can determine 10^{-5} to 10^{-3} M cyanide. Enzyme immobilization into a positively charged polymer, poly(4-vinylpyridine-co-styrene) (PVPy), seems to cause an increase in cyanide inhibition effects because of anion accumulation in the polymeric matrix, and the resulting sensor can measure cyanide concentration in the range 10^{-7} to 10^{-5} M. Fifty percent peroxidase inactivation was seen with 80 M KCN in the case of BSA-entrapped enzyme, and with only 0.6 M KCN when the enzyme was covered by PVPy film. Because of the reversible nature of peroxidase inhibition with cyanide ions, restoration of the enzyme activity after inhibition can be accomplished by sensor rewashing in fresh buffer.

Cyclic and Open Chain Aza-Oxa Ferrocene-Functionalised Derivatives as Receptors for the Electrochemical Sensing of Toxic Heavy Metal Ions in Aqueous Environments
Lloris, J.M.; R. Martinez-Manez; M.E. Padilla-Tosta; T. Pardo; J. Soto; P.D. Beer; J. Cadman; D.K. Smith.
Journal of the Chemical Society, Dalton Transactions, Vol 999 No 14, 2359-2369, 21 Jul 1999

A new family of aza-oxa open-chain and macrocyclic molecules functionalized with ferrocenyl groups has been synthesized and characterized. The crystal structures of the salts have been determined by single crystal X-ray procedures, and they consist of cationic protonated amines linked via ionic interactions with hexafluorophosphate anions. Hydrogen-bonding interactions also have been found. The receptors have been designed to promote discrimination, using electrochemical techniques, between toxic heavy metal ions such as Hg^{2+} over other cations commonly present in aqueous environments. The presence in the receptors of oxygen and nitrogen donor atoms has been used to control the selectivity of large metal ions over small ones. Potentiometric and electrochemical studies have been mainly carried out to find pH ranges of selective electrochemical recognition. Good agreement has been found between potentiometric and electrochemical results. Selective electrochemical response against Hg^{2+} appears to be associated with pH ranges of selective complexation or the existence of strong predominant receptor-metal complexes in a wide pH range. The researchers believe that this is the first time it has been shown that metal complexes functionalized with ferrocenyl groups can electrochemically sense anions.

Demonstration of a Continuous, Real-Time Biomonitor for the Detection of Toxic Chemicals in Water

Schalie, William H. van der; M.W. Widder; T.R. Shedd, Army Center For Environmental Health Research, Fort Detrick, MD.
Proceedings of the Workshop on Advanced Technologies in Real-Time Monitoring and Modeling for Drinking Water Safety and Security, Newark, NJ, June 2002. NTIS: ADA414100, 1 p, Jun 2002

An automated biomonitoring system has been developed to provide a rapid response to developing toxicity caused by a broad spectrum of individual chemicals or chemical mixtures. The biomonitor detects sublethal changes in fish behavior by continuously tracking the ventilatory rate and depth, cough rate, and whole body movement of eight individual fish (bluegills, *Lepomis macrochirus*). Key water quality parameters monitored continuously include temperature, dissolved oxygen, pH, and conductivity. When changes in fish behavior cause a pre-determined alarm threshold to be exceeded, the biomonitor initiates an automated water sampler to allow follow-on analytical chemistry evaluations and provides immediate notification of appropriate individuals through an autodialer. Software enables access to the ventilatory data from remote locations for alarm follow-up and diagnostic evaluations. Use of two sets of eight fish ensures continuous water monitoring, and routine maintenance requires approximately four hours per week. Data for a limited number of chemicals indicate that the biomonitor is likely to respond within an hour to concentrations at or below the 96-h LC50 (the level lethal to half the exposed animals in 4 days). The biomonitor is being used to continuously monitor source water for a water treatment plant. Biomonitor improvements in progress include a graphical user interface, an expert system to better identify biomonitor responses due to toxicity, and Internet accessibility. The biomonitor complements chemical surveillance techniques by providing continuous, real-time monitoring for unsuspected chemicals, chemical mixtures, and transient events, and by giving early warning of potential toxicity.
http://handle.dtic.mil/100.2/ADA414100

Demonstration of a Method for the Direct Determination of Polycyclic Aromatic Hydrocarbons in Submerged Sediments
Grundl, Timothy J.; J.H. Aldstadt III; J.G. Harb; R.W. St. Germain; R.C. Schweitzer, Univ. of Wisconsin-Milwaukee, Milwaukee.
Environmental Science & Technology, Vol 37 No 6, p 1189-1197, 15 Mar 2003

This paper describes the development of a novel method for real-time in situ characterization of polycyclic aromatic hydrocarbons (PAHs) in submerged freshwater sediments. Researchers adapted laser-induced fluorescence (LIF) spectroscopy for shipboard use and designed a cone penetrometer-type apparatus for probe penetration at a constant rate (1 cm/s) to a depth of 3 m. A field-portable LIF system was used for in situ measurements in which the output of a pulsed excimer laser was transmitted by optical fiber to a sapphire window (6.4-mm o.d.) in the probe wall; fluorescent emission was collected by a separate optical fiber for transmission to the spectrometer on deck. Four wavelengths (340, 390, 440, 490 nm) were selected via optical delay lines, and multiple-wavelength waveforms were created. These multiple-wavelength waveforms contain information on the fluorescence frequency, intensity, and emission decay rate. Field testing was conducted at 10 sites in Milwaukee Harbor where total PAH concentrations ranged from ~10 to 650 ug/g; conventional sediment core samples were collected concurrently and analyzed by EPA methods 3545 and 8270C for PAHs.

Design and Implementation of a Non-Invasive Water Sampling Program to Characterize the Temporal Variation of Stream and River Water Quality Effects of Three Abandoned Cu-Zn Mines in the Sierra Nevada Foothills, California: Combining GIS, Digital Field Data, and Time-Series Chemical Data
Takagi, T.K.; G.H. Brimhall, University of California, Berkeley.
IAMG2001: Annual Conference of the International Association for Mathematical Geology, 6-12 September 2001, Cancun, Mexico. 16 pp, 2001

The authors have developed a method for rapid and non-invasive mine site characterization with a digital mapping system and periodic water sampling. Lack of access to abandoned mine sites is a serious impediment to site characterization. The proposed approach includes helicopter-based GPS and laser digital mapping and spectroscopy. This method is being utilized to characterize historically mined volcanogenic massive sulfide deposits in the Sierra Nevada Foothills, due to their unique potential for acid generation. The mappable soluble salts that precipitate on the surface of mine waste dumps are washed down to the streams and rivers that drain these mine sites in the wet season, contributing to increased metal loading. Monthly and bimonthly water sampling and analysis by atomic absorption spectroscopy characterizes this temporal variation in water chemistry and its link to the changing surface mineralogy of these abandoned mine dumps. Design of the sampling program began with the compilation of watershed and monitoring station maps, property boundary maps, and street maps; those data were used in combination with geologic and topographic maps to determine sampling locations. In the field, water sampling sites were located to sub-meter accuracy using a GPS and were mapped on a pen computer using GeoMapper software. Features not shown on published maps, such as intermittent or small stream drainages, old mine structures, access roads, gates, and fences also were located and mapped. The water chemistry data and field measurements, along with the published and digitally-produced field maps, provide powerful tools for determining the effect of acid mine drainage on water quality.

Designing a Water Quality Monitor Using an Array of ISEs
Buehler, M.G.; S.P. Kounaves; D.P. Martin; S.J. West; G.M. Kuhlman.
2001 IEEE Aerospace Conference Proceedings, Vol 1, p 331-338, 2001

This effort is directed at developing a sensor for evaluating water quality onboard the International Space Station. A set of nine ion selective electrodes (ISEs) are being fabricated on a 4.5-cm diameter ceramic substrate. This paper discusses the design and fabrication of the deposition chamber and the ceramic substrates that form the basis for the ISEs. The chamber, substrate, and electronics design were validated to assure that the multiplexing electronics function, the ceramic substrate mounted is stress-free, and the deposition chamber is water tight. The authors present results from the electrolysis of a dilute nitric acid solution to further validate the design concept.

Designing and Implementing Perimeter Air Monitoring Programs for MGP Site Remediations
Gendron, Leo J.; Anthony Sacco; Ishrat Chaudhuri, ENSR International, Westford, MA.
The 18th Annual International Conference on Contaminated Soils, Sediments and Water, 21-24 October 2002, University of Massachusetts at Amherst.
Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. CD-ROM, 2002

This paper offers general guidance on the development and implementation of perimeter air monitoring programs for MGP site remediation projects. The authors address site-specific perimeter monitoring and data quality objectives, parameters to be measured, determination of action levels for the various parameters, types of instrumentation available, number and placement of fenceline monitoring locations, frequency of sampling, data telemetry and reporting alternatives, routine field operations and equipment QC protocols, perimeter monitoring program conceptual design and regulatory review, and monitoring plan generation.

Detection and Measurement of Explosives in Groundwater Using In Situ Electrochemical Sensors
Olsen, Khris B. (Pacific Northwest National Lab., Richland, WA); Joseph Wang.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 41, 2002

During the course of this 2001 SEED Strategic Environmental Research and Development Program (SERDP) project, various working electrode materials and voltammetric waveforms were compared, and relevant experimental parameters were optimized. Based on this initial testing a submersible electrochemical probe was developed using a carbon-fiber electrode assembly connected to a 50-foot-long shielded cable, for the real-time monitoring of nitro-organic explosives in natural water. The facile reduction of the nitro moiety group allowed convenient and rapid square-wave voltammetric measurements at trace levels of nitroaromatic explosives (TNT, TNB, and Tetryl) down to levels of 50 to 100 ppb. A newly developed background subtraction algorithm was used to minimize background contributions. A highly stable response (with relative standard deviations of 1.0 to1.5%) was observed for prolonged (10 hour) operations in natural water samples, with no apparent surface fouling. Detection limits for nitroamine explosives (HMX and RDX) and nitrocellulose were in the range of 1 to 2 ppm. The peak potentials for nitroamine explosives are directly superimposed onto the oxygen peak in the voltammogram, resulting in significant increase in detection limits. This interference, caused by the presence of oxygen, complicates the procedures required to measure nitroamine explosives in ground water. To successfully measure nitroamine compounds, oxygen removal will be required. With oxygen removal, detection limits for nitroamine explosives should approach those of the nitroaromatic explosives. Several potential interferences were investigated including mono- and di-nitrotoluene, 4-amino-2,6-dinitrotoluene, trichloroethene (TCE), nitrates, chromate, and perchlorate. Laboratory studies determined only degradation products of nitroaromatic explosives that still contain a nitro group interfere with the measurement of the nitroaromatic parent explosive. Other common co-contaminates did not interfere with the measurements.

Detection of VX Contamination in Soil Through Solid-Phase Microextraction Sampling and Gas Chromatography/Mass Spectrometry of the VX Degradation Product Bis(diisopropylaminoethyl)disulfide
Hook, Gary L.; G. Kimm; D. Koch; P.B. Savage; B. Ding; P.A. Smith, Uniformed Services Univ. of the Health Sciences, Bethesda, MD.
Journal of Chromatography A, Vol 992 No 1-2, p 1-9, 11 Apr 2003

A solid-phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS) sampling and analysis method was developed for bis(diisopropylaminoethyl)disulfide (a degradation product of the nerve agent VX) in soil. A 30-min sampling time with a polydimethylsiloxane-coated fiber and high temperature alkaline hydrolysis allowed detection with 1.0 ug of VX per g of VX-spiked agricultural soil. The method was successfully used in the field with portable GC-MS instrumentation. This method is relatively rapid (less than 1 h), avoids the use of complex preparation steps, and enhances analyst safety through limited use of solvents and decontamination of the soil before sampling.

Determination of Metal Cyanide Complexes in Gold Processing Solutions by Capillary Electrophoresis
Aguilar, M.; A. Farran; V. Marti.
Journal of Chromatography A, Vol 767 No 1-2, p 319-324, 11 Apr 1997

A capillary electrophoresis method to determine metal cyanide complexes and sulphur compounds in gold processing solutions using direct UV absorbance detection is based on the use of electroosmotic flow modifiers to control separation and in the on-column concentration of the sample by using the stacking effect to increase the sensitivity. By optimizing the analytical conditions, analysis times of less than 15 min and detection limits of metals in the mid-ppb range have been obtained with good resolution. The quantitation and determination of the metal cyanide complexes Au(CN), Ag(CN), Cu(CN), Ni(CN), Fe(CN), and HS-, and SCN-, present in samples from the leaching of a gold mineral and a gold sand by a sodium cyanide (NaCN) solution, has been achieved. The evolution of the formation over time of gold cyanide complexes under leaching conditions has been studied using the proposed analytical method.

Development and Characterization of Molecularly Imprinted Sol-Gel Films for the Selective Detection of DDT [1,1-Bis(4-chlorophenyl)-2,2,2-trichloroethane]
Edmiston, Paul L. (The College of Wooster, Wooster, OH); Amy L. Graham; Catherine A. Carlson.
PITTCON 2001, Abstracts, p 1363, 2001

Researchers have developed a chemical sensor for the pesticide DDT using covalent molecularly imprinted sol-gel films. The scientists used 4,4'-ethylene-dianiline, which has a similar size and shape as DDT, as a covalently bound template molecule to imprint DDT binding sites. A porous sol-gel based material was polymerized around the template molecules. The template was then chemically removed to generate binding sites appropriate for DDT. The sol-gel material was deposited as films on glass substrates for measurements. FTIR-ATR (attenuated total reflection) was used to characterize the chemistry of the films and determine whether the films bound DDT analogues. The sensor showed high sensitivity and good selectivity to DDT, though relatively small changes in fluorescence were seen, limiting the practical use of the current design to chemical sensing applications.

Development, Demonstration, and Validation of Microfabricated Iridium and Gold Arrays for the Field Screening of Heavy Metals in Ground Water
Feeney, Rosemary, thesis (Ph.D.), Tufts University.
University Microfilm, Inc., Ann Arbor, MI. UMI Pub No: AAT 3035065, ISBN: 0-493-48668-2, 111, 2002

The objective of the research was to develop and demonstrate the utility of a low-cost, field-portable analytical device for the rapid screening of heavy metals in ground water. The devise centers on microfabricated iridium and gold arrays, which are small, rugged, relatively inexpensive, and provide measurable currents at the low parts-per-billion to parts-per-trillion level. The electrochemically-based metal analyzer (EMA) was developed with support from the Northeast Hazardous Substance Research Center at the New Jersey Institute of Technology. All the experiments involved mercury deposited onto the iridium arrays (Ir(Hg)UMEAs). The studies demonstrated reproducibility, stability, and reasonable lifetimes. The analytical capabilities of the UMEAs were investigated and verified with comparisons to standard EPA spectrometric methodologies. Excellent linearity was obtained with both arrays when concentrations and the SW frequencies were varied. Experimental detection limits were determined to be 0.65, 0.28, 0.2 and 0.1 ppb for cadmium, lead, copper on Ir(Hg)UMEAs, and arsenic on AuUMEAs, respectively. Successful demonstrations of the utility of the EMA took place at four hazardous waste sites with metal contaminants in ground water.

Development of a High Performance Liquid Chromatography Method to Monitor the Biodegradation of Naphthenic Acids
Clemente, J.S.; T.-W. Yen; P.M. Fedorak.
Journal of Environmental Engineering Science/Reviews in General Science of the Environment, Vol 2 No 3, p 177-186, 2003

Naphthenic acids comprised mainly of a complex mixture of carboxylic acids are found in wastewaters from petroleum refineries and from the extraction process used to recover bitumen from large oil sands deposits found in northeastern Alberta, Canada. Biodegradation reduces the toxicity of naphthenic acids. A high performance liquid chromatography (HPLC) method was developed to follow the removal of naphthenic acids from aerobic laboratory cultures. Small samples of the culture supernatants were derivatized with 2-nitrophenylhydrazine, and the derivatized carboxylic acids were separated from the excess derivatizing agent by HPLC. The derivatized acids eluted as an unresolved hump in the chromatogram. Comparing the areas under the humps in standard preparations (containing 5 to 200 mg naphthenic acids/L), and in culture supernatants allowed measurements of the depletion of naphthenic acids from the microbial cultures. Three naphthenic acids preparations were studied, and up to 40% of the naphthenic acids were removed by cultures during 30- to 40-day incubation periods. Carbon dioxide formation accompanied the decrease in the naphthenic acids concentration determined by HPLC.

Development of a Real-Time Fluorescence Detection System for Vapor Polycyclic Aromatic Hydrocarbons at Elevated Temperatures
Chi, Zhenhuan (Oak Ridge National Lab, Oak Ridge, TN); Brian M. Cullum; Tuan Vo-Dinh.
PITTCON 2001, Abstracts, p 700, 2001

Scientists at ORNL have developed a real-time fluorescence detection system for polycyclic aromatic hydrocarbon (PAH) vapors at high temperatures ranging from 400 to 870 degrees K. The fluorescence detection system is excited by a nitrogen laser. This system can monitor in situ PAH vapor formation and concentration in real time. The researchers have measured vapor fluorescence spectra of several typical PAH compounds--anthracene, pyrene, phenanthrene, and chrysene--and also have examined the temperature effects on PAH vapor fluorescence spectra such as spectral shift, intensity, and band width. Individual PAH composition in a vapor mixture has been determined with chemometrics.

Development of a Surface Enhanced Raman Spectroscopy (SERS)-Based Sensor for the Long Term Monitoring of Toxic Anions
Boss, Pamela A., Space and Naval Warfare Systems Center, San Diego, CA.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 33, 2002

The ideal field-deployable sensor would be able to detect toxic anions reversibly in the low ppb concentration range, in situ, on site, with little or no sample preparation, and with no interferences. One technology that meets many of these criteria is Surface Enhanced Raman Spectroscopy (SERS) using cationic-coated silver substrates. SERS has advantages of specificity and sensitivity over other spectroscopic techniques. All polyatomic species will exhibit a characteristic Raman signature that can be used to both identify and quantify it, but with time, these substrates oxidize, resulting in a decrease in the SERS signal. To protect the silver or gold SERS substrates from degradation, the surface is allowed to react with a thiol to form a self-assembled monolayer. The added advantage with this approach is that thiol coatings can be chosen to attract the analytes of interest. In this SERDP-sponsored effort, detection of chromate, dichromate, perchlorate, and cyanide using cationic-coated SERS substrates has been demonstrated. Limits of detection in the ppb-ppm concentration range have been achieved. The coatings used in this investigation possess no anion recognition functionalities, other than a positive charge; consequently these coatings interact simultaneously with different anions. Means of improving selectivity have been examined, such as identifying ionophores specific for the anions and removal of the interferences using solid phase extraction, supported liquid membranes, and nanotubule technology. The electrochemical etching parameters have been optimized to lower the detection limit. A sensor module has been designed that can be used either stand-alone or inserted inside a modified, cone penetrometer sampler probe. The sensor module is used stand-alone immersed in samples obtained from monitoring wells. Inserting the sensor module inside a cone penetrometer sampler probe allows sampling of ground water at various depths. Either approach will provide monitoring data in real time without the additional cost of an outside lab.

Development of Nanomechanical Biosensors for Detection of the Pesticide DDT
Alvarez, M.; A. Calle; J. Tamayo; L.M. Lechuga; A. Abad; A. Montoya.
Biosensors and Bioelectronics, Vol 18 Nos 5-6, p 649-653, May 2003 [Selected papers from the Seventh World Congress on Biosensors Kyoto, Japan 15-17 May 2002]

A novel technique for detection of the organochlorine insecticide DDT has been achieved by measuring the nanometer-scale bending of a microcantilever produced by differential surface stress. A synthetic hapten of the pesticide conjugated with bovine serum albumin was covalently immobilized on the gold-coated side of the cantilever by using thiol self-assembled monolayers. The immobilization process is characterized by monitoring the cantilever deflection in real-time. Specific detection is achieved by exposing the cantilever to a solution of a specific monoclonal antibody to the DDT hapten derivative. The specific binding of the antibodies on the cantilever sensitized side is measured with nanomolar sensitivity. Direct detection relies on competitive assays, in which the cantilever is exposed to a mixed solution of the monoclonal antibody and DDT.

Development of Optical Remote Sensing Protocol for the Measurement of Nonpoint Emission Sources
Sullivan, Patrick D. (Air Force Research Lab., Tyndall AFB, FL); Ram A. Hashmonay.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 134, 2002

No standard protocol exists yet for making nonpoint source measurements for an air emission flux. An accurate and cost-effective method is needed to quantify nonpoint emission sources. Current estimation techniques for nonpoint sources based on emission factors are imprecise and typically overestimate drastically. Multiple point measurements are locally accurate but may not be representative of the entire plume, and they are expensive in the quantities required. A cooperative effort between the DoD and EPA has recently been initiated to develop and demonstrate a standardized nonpoint source measurement protocol based on path-integrated optical remote sensing (PI-ORS) and computed tomography. The protocol uses multiple beam paths and optimizing algorithms to give a time-averaged, mass-equivalent concentration field across a plume of contaminant, from which the emission rate can be determined without using estimated values from a dispersion model. The protocol will be refined and demonstrated at multiple DoD sites, and a measurement performance specification for the protocol will be published by the EPA at the conclusion of the project. Support for this project is being provided by ESTCP.

Development of Sediment Extracts for Rapid Assessment of Organic Contaminant Bioavailability
Price, Cynthia; L. Inouye; J.M. Brannon; V. McFarland; C. Hayes, Army Engineer Research and Development Center, Vicksburg, MS.
Report No: ERDC/TN-EEDP-02-31, NTIS: ADA413697, 10 pp, Apr 2003

This technical note describes the development of sediment extraction procedures for evaluating the bioaccumulation potential of non-polar organic contaminants from dredged material. The paper describes potential approaches and outlines the experimental procedure of the sediment extraction approach for assessing bioavailability.
http://handle.dtic.mil/100.2/ADA413697

Development of Sensitive Analytical Methodology for Airborne Isocyanates -- Denuder Sampling and LC-APCI-MS
Nordqvist, Y. (Stockholm Univ., Stockholm, Sweden); A.L. Colmsjo; R. Johansson; U.L. Nilsson.
PITTCON 2001, Abstracts, p 928, 2001

Scientists evaluated a personal monitoring denuder sampler for trapping toluene diisocyanate (TDI). Reproducibility, recovery, and capacity were studied for mainly the gaseous phase and compared to impinger sampling, one of the most common methods for airborne isocyanates. The denuder consists of a cylindrical tube connected to a personal sampling pump. The inside of the tube is coated with SE-30 containing dibutylamin (DBA) as a reagent for collection and derivatization of isocyanates. A denuder can separate the gas phase from compounds associated to particles. By diffusion, gaseous compounds are selectively trapped by the stationary phase inside the tube, while particles pass through due to a laminar flow. Particles can be collected on something like a DBA-impregnated filter at the end of the tube. The TDI-DBA adduct, formed after derivatization of the sampled TDI, can be detected with high sensitivity by LC-APCI-MS using MS/MS. The LOD of the complete analytical method, based on a 15 minutes sampling time, is several times below 5ppb, which is the Swedish occupational exposure limit for 8 hours. Furthermore, denuder sampling exhibited high reproducibility and could be performed during eight hours with maintained efficiency.

Direct Detection of Dense Non-Aqueous Phase Liquids in the Subsurface Using Geophysical Techniques
North, Loren E. (CDM MISSIMER, Ft. Myers, FL); Mark T. Stewart.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 32, 2002

Dense non-aqueous phase liquids (DNAPLs) are heavier than water, making them more difficult to locate and quantify in the subsurface. This study attempts to directly detect and quantify DNAPL beneath the water table by measuring the bulk dielectric and porosity. A three-phase mixing equation is used to derive the amount of DNAPL occupying available pore space. The dielectric constant of water is about 80, the dielectric constant of common DNAPLs ranges from 3 to 5, and the dielectric constant of quartz is 4.5. Either the presence of DNAPL or a decrease in porosity will cause a decrease in bulk dielectric. By measuring the variation of the dielectric constant with porosity, it is possible to distinguish changes in the dielectric as a result of changes in porosity or DNAPL saturation. The study was completed at Ordnance Support Facility 1381, Cape Canaveral Air Force Station, FL, where VOCs are present in the subsurface. Gamma-gamma logging was completed in five wells to measure bulk density, from which porosity is derived. Bulk dielectric was measured in four locations surrounding each monitor well using cone penetrometer technology. The results from each tool were interpolated to the same elevation. DNAPL volume as a fraction of available pore space was derived using known dielectric values for water, soil, and DNAPL and measured values of bulk dielectric and calculated porosity. Roth’s three-phase mixing equation (1990) was used to derive fractional DNAPL saturation. Decreases in bulk dielectric can be associated with increases in DNAPL volume at corresponding elevations. A comparison of fractional DNAPL volume, fractional water volume, and porosity versus bulk dielectric demonstrates that DNAPL must be present. A plot of measured bulk dielectric versus gamma-derived porosity is a random data cluster. If fractional water content is calculated by subtracting calculated fractional DNAPL content from porosity, a plot of water content versus bulk dielectric agrees closely with Topp’s (1980) equation relating soil moisture to bulk dielectric. As the only difference between porosity and water volume, both mathematically and in the physical system, is the presence of DNAPL, the agreement of the calculated fractional water content with Topp’s equation demonstrates that this method succeeded in directly detecting and quantifying DNAPL.

Direct Detection of Dense Nonaqueous Phase Liquids (DNAPL) Using High Resolution Reflection Seismic Techniques at the SWMU-12 Site Charleston, Naval Weapons Station, Charleston, South Carolina
Waddell, Michael G. (Univ. of South Carolina, Columbia, SC); William J. Domoracki.

Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 35, 2002

The Charleston Naval Weapons Station SWMU-12 site was selected for high resolution seismic analysis. Initially, three vertical seismic profiles (VSP) and an experimental P-wave seismic reflection line were collected. After preliminary analysis of the VSP data and the experimental reflection line data, the team proceeded with seismic acquisition, data processing, and data interpretation. Three high resolution P-wave reflection profiles were collected with two objectives: (1) image a target depth of 20 feet below land surface to assist in determining the geologic controls on the DNAPL plume geometry, and (2) apply Amplitude Variation with Offset (AVO) analysis to the seismic data to locate the zone of high concentration of DNAPL. Based on the results of the data processing and interpretation of the seismic data, the project team was able to map the channel controlling the DNAPL plume geometry. The AVO analysis located a major amplitude anomaly that was tested using a Geoprobe™ direct push system. The Geoprobe™ was equipped with a membrane interface probe (MIP) interfaced with a sorbent trap/gas chromatograph (GC) system. Both the photo ionization detector (PID) and electron capture detector (ECD) on the GC exceeded the maximum measurement limits through the anomaly identified from the AVO analysis. A well was installed to collect a water sample. The concentration of chlorinated solvents in the water sample was in excess of 500 ppm. Other amplitude anomalies located directly under an asphalt road also were tested. Both the PID and ECD registered zero at these locations. It appears that editing of poor quality near-offset seismic traces during data processing caused these anomalies. Not having the full range of source to receiver offset traces in those areas resulted in a false anomaly during AVO analysis. This phenomenon was observed at the beginning and end of each seismic profile for the same reason. Based on the water samples and MIP probes, it appears that surface seismic and AVO analysis were able to detect the area of highest concentration of DNAPL at the SWMU-12 site.

Direct Diffusion Sampling Based Photoacoustic Cell for In Situ and On-Line Monitoring of Benzene and Toluene Concentrations in Water
Mohacsi, A.; Z. Bozoki; R. Niessner.
Sensors and Actuators B, Vol 79 No 2-3, p 126-130, 15 Oct 2001

This paper discusses a photoacoustic (PA) sensor for in situ and on-line concentration monitoring of toluene and benzene in water. Selective detection was accomplished by transferring (by means of a permeable membrane) the analyte of interest into the gas phase. In the conventional approach, sampling and the detection unit are separated, but here the membrane is inserted directly into the central part of the photoacoustic resonator, eliminating the need for various gas-handling components as well as the use of a purging gas. The proposed system is simpler and more compact, with a response time of 40 min and a potential for fully automated operation. The use of a near-infrared (1.67 m) diode laser coupled to the PA cell by an optical fiber resulted in detection limits of 350 g (for benzene) and 1.1 mg (for toluene) per liter of water. The PA sensor can serve as a warning system for long-term and automatic observation when placed directly into water wells.

Direct Push Electrical Resistivity Tomography for Evaluation of an LNAPL Plume
McSorley, Jerome; M. McPhail; T. Halihan; S.T. Paxton, Oklahoma State Univ., Stillwater.
GSA 2002 Denver Annual Meeting, 27-30 October 2002. Geological Society of America, Paper No. 83-8

A site in Enid, OK, was selected to test the effectiveness of a new method for monitoring LNAPL plumes. Direct push ERT supplements the surface measurement technique with a grid of direct push boreholes containing vertically spaced monitoring electrodes in a configuration that provides a monitored area or volume for the contaminated site with good depth resolution. Data from continuous sediment cores and electrical conductivity logs taken prior to system installation to describe the lithology, stratigraphy, and geophysical characteristics of the site are being used to evaluate and calibrate the ERT data. The monitoring grid consists of boreholes on 10m spacing with push penetration to depths of approximately 12 meters. Each vertical borehole has 28 evenly spaced electrodes set up to work in conjunction with 36 surface electrodes. The electrode monitoring grid can providing electrical resistivity data at a vertical resolution of 0.25 meters on a temporary or permanent basis.

Disposable Amperometric Immunosensor for the Detection of Polycyclic Aromatic Hydrocarbons (PAHs) Using Screen-Printed Electrodes
Fahnrich, K.A.; M. Pravda; G.G. Guilbault.
Biosensors and Bioelectronics, Vol 18 No 1, p 73-82, Jan 2003

A new amperometric immunosensor for polycyclic aromatic hydrocarbons (PAHs) is based on disposable screen-printed carbon electrodes. The coating antigen is phenanthrene-9-carboxaldehyde coupled to bovine serum albumin (BSA) via adipic acid dihydrazide. Antibodies were monoclonal mouse anti-phenanthrene. The enzyme alkaline phosphatase (AP) was used in combination with the substrate p-aminophenyl phosphate for detection at +300 mV (vs. Ag/AgCl). Various assay types were compared. Good results were achieved with an indirect co-exposure competition assay with a LOD of 0.8 ng/ml (800 ppt) and an IC50 of 7.1 ng/ml (7.1 ppb) for phenanthrene. The influence of the coating concentration on the sensor performance was investigated, and cross-reactivities were tested for 16 important PAHs. Anthracene and chrysene showed strong cross-reactivity, though benzo[g,h,i]perylene and dibenzo[a,h]anthracene showed none.

Disposable Tyrosinase-Peroxidase Bi-Enzyme Sensor for Amperometric Detection of Phenols
Chang, Seung Cheol; Keith Rawson; Calum J. McNeil.
Biosensors and Bioelectronics, Vol 17 Nos 11-12, p 1015-1023, Dec 2002

A new disposable amperometric bi-enzyme sensor system for detecting phenols uses horseradish peroxidase modified screen-printed carbon electrodes (HRP-SPCEs) coupled with immobilized tyrosinase. The tyrosinase is prepared using poly(carbamoylsulfonate) (PCS) hydrogels or a poly(vinyl alcohol) bearing styrylpyridinium groups (PVA-SbQ) matrix. Comparison of the electrode responses with the 4-aminoantipyrine standard method for phenol sample analysis indicated the feasibility of the disposable sensor system for sensitive determination of phenols in the field. The most sensitive system was the tyrosinase-immobilized HRP-SPCE using PCS, which displayed detection limits for phenolic compounds in the lower nanomolar range: 2.5 nM phenol, 10 nM catechol, and 5 nM p-cresol.

A Distributed Sensor for Pipe Line Leak Detection
Saini, Devinder Pal (FCI Environmental, Inc., Las Vegas, NV); Peter Lagergren.
PITTCON 2001, Abstracts, p 926, 2001

Pipelines can extend for hundreds of miles, requiring thousands of point sensors for effective leak detection. Currently, leaks are detected by visual inspection or by monitoring the pressure in the pipeline. These methods will detect major catastrophic leaks but are unable to detect small leaks. This paper describes a distributed sensor that relies on fiber-optic technology capable of detecting leaks over considerable distances. The hydrocarbon sensor is based on a fiber-optic sensor already being used in the petroleum industry. Applications include storage tank leak detection, ground-water monitoring, oil-in-water monitoring of produced water on offshore platforms, and process water monitoring. The distributed sensor uses a proprietary coating at equidistant intervals and an Optical Time Domain

Reflectometer (OTDR) in conjunction with Low Earth Orbit Satellite communications to provide continuous monitoring of pipelines.

E-Smart System for In-Situ Detection of Environmental Contaminants
Leffler, S.
Report No: DOE/ID/13352, NTIS: DE00765368, 112 pp, Mar 2000

A team of industrial, academic, and government organizations participated in the development of the Environmental Systems Management, Analysis and Reporting Network (E-SMART). E-SMART integrates diverse monitoring and control technologies by means of a modular, "building block" design approach to allow for flexible system configuration. The E-SMART network treats each smart device--whether a sensor, sampler, or actuator--as a black box that obeys the standard communication protocols and electrical interfaces for the network. This approach allows multiple vendors to produce different sensors that meet the same functional specification and can be interchanged on the network without affecting operation. The project further developed and advanced the E-SMART standardized network protocol to include new sensors, sampling systems, and graphical user interfaces. Specifically, the E-SMART team developed the following three system elements: (1) base technology for a new class of smart , highly sensitive, chemically specific, in situ, multichannel microsensors utilizing integrated optical interferometry technology; (2) a set of additional E-SMART-compatible sensors adapted from commercial off-the-shelf technologies; and (3) a data management and analysis system that includes network management components and a user-friendly graphical user interface (GUI) for data evaluation and visualization.
http://www.osti.gov/dublincore/gpo/servlets/purl/765368-c1a2fx/webviewable/

Effect of Immiscible Liquid Contaminants on P-Wave Transmission Through Natural Aquifer Samples
Geller, Jil T.; J.B. Ajo-Franklin; E.L. Majer, Lawrence Berkeley National Lab., Berkeley, CA.
2003 Annual Meeting/SAGEEP, 6-10 April 2003, San Antonio, TX.
Report No: LBNL-52131, 19 pp, Jan 2003

Researchers performed core-scale laboratory experiments to examine the effect of non-aqueous phase liquid (NAPL) contaminants on P-wave velocity and attenuation in heterogeneous media. This work is part of a larger project to develop crosswell seismic methods for minimally invasive NAPL detection. The test site is the former DOE Pinellas Plant in Florida, which has known NAPL contamination in the surficial aquifer. Field measurements revealed a zone of anomalously high seismic attenuation that may be due to lithology and/or contaminants (NAPL or gas phase). Intact core was obtained from the field site, and P-wave transmission was measured by the pulse-transmission technique with a 500 kHz transducer. Two types of samples were tested: a clean fine sand from the upper portion of the surficial aquifer, and clayey-silty sand with shell fragments and phosphate nodules from the lower portion. Either NAPL trichloroethene or toluene was injected into the initially water-saturated sample. Maximum NAPL saturations ranged from 30 to 50% of the pore space. P-wave velocity varied by approximately 4% among the water-saturated samples, while velocities decreased by 5 to 9% in samples at maximum NAPL saturation compared to water-saturated conditions. The clay and silt fraction as well as the larger scatterers in the clay-silt sands apparently caused greater P-wave attenuation compared to the clean sand. The presence of NAPLs caused a 34 to 54% decrease in amplitudes of the first arrival. The central frequency of the transmitted energy ranged from 85 to 200 kHz, and was sensitive to both grain texture and presence of NAPL. The results are consistent with previous trends observed in homogeneous sand packs. More data will be acquired to interpret P-wave tomograms from crosswell field measurements, determine the cause of high attenuation observed in the field data, and evaluate the sensitivity of seismic methods for NAPL detection.
http://www.osti.gov/dublincore/gpo/servlets/purl/809308-dSMrLv/native/

Effect of Permeating Solutions on Complex Permittivity of Compacted Clay
Rowe, R.K.; J.Q. Shang; Y. Xie.
Canadian Geotechnical Journal/Reviews in Canadian Geotechnology, Vol 39 No 5, p 1016-1025, 2002

The complex permittivity of a natural clayey till was measured before and after permeating with four different ionic contaminant solutions ($CaCl_2$, $MgCl_2$, NaCl, and acetic acid) to examine the effects of contaminant type and concentration on the complex permittivity of contaminated soil. The complex permittivity at 250 MHz is most sensitive to the concentration of the ions in the pore fluid, and a good linear correlation is obtained between the real and the imaginary parts of the complex permittivity and the concentrations of the anions, including chloride and acetate. The results indicate that the complex permittivity of soils can be used to identify changes in soil pore-water chemistry and thus may have potential for the detection of soil contamination.

Electrical Conductivity of Dissimilatory Metal-Reducing Bacteria (DMRB) at Different Life Phases Influenced by Chromium(VI)
Minyard, Morgan L.; W.L. Wempe, Univ. of Colorado, Boulder, CO.
GSA 2002 Denver Annual Meeting, 27-30 October 2002. Geological Society of America, Paper No. 83-6

Researchers have found that common organic (e.g., tetrachloride, TCE, TNT) and inorganic contaminants (e.g., Cr, U, Tc) can be reduced coupled with the reduction of Fe(III) to Fe(II) by dissimilatory iron-reducing bacteria (DMRB). These DMRB can be placed in bioremediation reactive zones to treat ground water or soils. Understanding the influence of DMRB on conductivity could enable better monitoring of bioremediation progress in the subsurface. The researchers investigated the influences of an iron reducer called *Shewanella putrefaciens* CN32 on chromate (in the form of potassium dichromate) on the conductivity measurements. For each reduction constituent and for each phase of the DMRB life cycle, a platinum-plated electrical conductivity probe was used to measure electrical conductivities under both aerobic and anaerobic conditions. Changes in electrical conductivity were noted during the Fe(III) reduction process that might be detectable with in situ electrical conductivity or resistivity tools to monitor remediation progress.

Electrical Leak Location and Sandstone Resistivity Monitoring Using a Geophysical System Permanently Installed below a Lined Landfill Site in the UK
Taylor, S.B., Ph.D. thesis, University of Birmingham, UK. 2000

With a geophysical monitoring system permanently installed below a landfill liner, holes in the liner detected at the construction and initial landfilling stage can be repaired, whereas repair of holes detected at the post landfilling and remediation stage might be impossible. In the event of detection of an irreparable hole, the system can monitor the resistivity of the material beneath the liner for signs of any contaminant release and subsequent migration. This thesis details the first three years of monitoring and associated research of the U.K.'s first permanent below-liner monitoring system at the Sandy Lane Landfill Site in the English Midlands. A comparative study of above- and below-liner leak detection methods indicates that the response to a leak is generally less below the liner than above, unless the resistivity of the below-liner material is greater than five times that of the material above the liner. Detection below the liner is less affected by background potential gradients. Comparison of field data with analytical leak models indicates significant differences, mainly due to the variation in the amount of current flowing through the hole. The current flowing through the hole was found to be the most important factor in enabling leaks to be detected. Data collected during the life of the landfill emphasize the efficacy, sensitivity, and importance of a below-liner system in the detection of leaks; holes as small as pin-holes have been successfully detected and located. A method for improving the leak-location accuracy has improved detection from approximately 20 m to 1 m in some cases. Monitoring the resistivity of the sandstone beneath the landfill site shows changes in the vadose zone of up to 20% over time, possibly due to the vadose zone draining to an equilibrium distribution. Parameter values obtained from models have been used to evaluate the capability of the monitoring system in detecting contaminant escape from the site using the Wenner array. Results suggest that other array types should be considered for improved contaminant detection in the below-liner system.

An Electrochemically Modulated Waveguide Interferometer for Heavy Metal Determination
Ramos, Brigitte L., Denison Univ., Granville, OH.
PITTCON 2001, Abstracts, p 1350, 2001

A planar waveguide implementation of a Mach-Zehnder interferometer coated with a thin semiconducting film was fabricated. The semiconducting film was used as an electrode to provide an electrooptic sensor. Changes in the refractive index profile resulting from a potential scan can be detected by a shift in the interference pattern imaged across the face of a photodiode array. The author reports the fabrication of the electrooptic sensor and application of the device for the determination of lead. By utilizing Calcein Blue, a lead-ligand complex is formed that can be potentiostatically collected and stripped from the electrode surface, permitting this complex to be interferometrically observed at the HeNe wavelength. Results from the cyclic and differential pulse voltammetry, along with the refractive index (phase) response measure during electrochemical modulation, are discussed.

Environmental Monitoring with Glass Powder
Krickser, Anja (Bavarian Center for Applied Energy Research, Wurzburg, Germany); Zae Bayern, Joachim Kuhn, Jochen Fricke, Hannelore Roemich.
PITTCON 2001, Abstracts, p 739, 2001

Potash-lime-silicate (pls) glasses react with humidity and pollutants like sulfur dioxide, nitric oxides and organic acids, and also display synergetic effects. Sensors employing slices of such glasses can monitor the environmental impact on buildings, statues, and other structures important to our cultural heritage. The sensor works by analyzing the absorption band around 3 IJm in the IR-transmission spectra before and after an exposure time of several months. Work is under way to increase the sensitivity of glass sensors by applying a thin layer of pls-glass powder to an IR-transparent organic substrate. To correlate the reaction of the powder glass sensor with a defined climate, IR transmission measurements were performed before and after its exposure to the climate. An FTIR spectrometer with a 1.8 to 18 IJm spectral range combined with an integrating sphere is employed to monitor the transmission. Due to the shallow optical thickness of the powder layer, the progress of corrosion can be detected not just at 3 IJm (as is the case with glass slices) but at several additional bands, and considerably more information can be obtained. The progress of corrosion of the glass powder can be detected by observing the bands of silanol groups and molecular water, because corrosion increases the amount of these groups. Experiments show that different types of indoor and outdoor environments can be distinguished by their respective corrosivity levels after just a few days of sensor exposure.

Environmental Technology Verification Report: Groundwater Sampling Technologies, Burge Environmental, Inc., Multiprobe 100
Einfeld, W. (Sandia National Lab., Albuquerque, NM) ; E.N. Koglin, (U.S. EPA, Las Vegas, NV).
Report No: EPA 600-R-00-074, NTIS: PB2003-106589, 44 pp, Aug 2000

The Multiprobe 100 is a discrete, multi-level sampler designed for permanent deployment in a well. The sampler is designed for use with a complementary automated wellhead analyzer for TCE called the Optrode. Only the sampling module was evaluated in this test, not Optrode performance. The Multiprobe 100 consists of two units with tubing and wiring interconnections. An upper receiving module, which is deployed at the wellhead on top of the well, is 18 inches long, 3.25 inches in diameter, and weighs 3 pounds. The lower sampling module, which is inserted into the water column inside the well, is 12 inches long, 3.25 inches in diameter and also weighs 3 pounds. The system is constructed of Teflon, borosilicate glass, stainless steel and Delrin®, a solvent-resistant, acetal homopolymer resin. Electrical solenoid valves are used to select the sampling level and control gas flow to the sampler. Water level sensors in the water chambers of both modules trigger valve changes during the sampling process. A small, battery-operated microprocessor controller controls the valves during the sampling process. The lower sampling module is filled with water from the selected sampling level by hydrostatic pressure. The water sample is then pushed up to the upper receiving module by pressurizing the sampling chamber headspace with nitrogen gas. Samples can be manually dispensed into analysis vials from the upper receiving module; however, the system is primarily intended for interconnection with automated analyzers, such as the Optrode, which would also be positioned at the wellhead. The system can purge VOCs from water in situ with subsequent analysis by sensors, such as the Optrode, positioned in the headspace or at the wellhead. Following the purge, the vapors can be transported via tubing to the surface for collection and analysis. The in situ purge capability of the sampler was not tested in the demonstration. The results of this verification test show that the Multiprobe 100 multi-level sampler can be used to collect VOC-contaminated water samples that are generally statistically comparable to reference samples. Sampler recoveries for PCE in the aqueous sampling and transfer mode were consistently low when compared to reference samples. Further investigation of sampler performance for this compound may be required.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_burge.pdf

Environmental Technology Verification Report: Groundwater Sampling Technologies, Clean Environment Equipment SamplEase® Bladder Pump
Sandia National Lab. for U.S. EPA.
Report No: EPA 600-R-00-078, 42 pp, Aug 2000

The SamplEase® is a bladder pump consisting of an internal flexible Teflon bladder positioned within a rigid stainless steel pump body. The ends of the pump also are constructed of Teflon. The inner bladder is equipped with one-way inlet and outlet valves and passively fills with water when the pump is at depth in the well as a result of the hydrostatic pressure exerted by the surrounding water column. Following the fill cycle, compressed air or nitrogen in one tubing line from a cylinder or compressor at the wellhead drives the water sample up to the surface through a second tubing line. A controller varies the duration and frequency of the fill/compress cycles to deliver the desired sample flow rate at the wellhead. The Model SP15T36 pump tested during this evaluation uses polytetrafluoroethylene (Teflon) for the bladder and 316 stainless steel for the pump body, fittings, and intake screen. The pump and intake screen is 40 inches long. The pump diameter is 1.5 inches and its weight is 3.8 pounds. The pump has a maximum lift capacity of 500 feet, and flow rates are adjustable from less than 100 mL/min to over 5 L/min, depending on pump depth. The pump can draw samples from greater depths using an extended intake attached to the inlet of the pump. The Model SC250 controller is a mechanical controller used to regulate the flow of compressed nitrogen, obtained from a cylinder at the wellhead, to the bladder pump. The controller is weatherproof and is packaged in a durable case that can be easily hand carried. The controller has overall dimensions of 10 x 9 x 7 inches and a weight of 9.8 pounds. Drive air for the bladder pump can be delivered from compressed gas cylinders or from a field-portable gasoline- or electric -powered compressor. The bladder pump's list price is $630 and the controller lists at $1,550. An optional inlet screen is priced at $50. Teflon-lined polyethylene dual tubing is also a requirement for most VOC sampling applications and is priced at $1.30 per foot. The results of this

verification test show that the SamplEase® bladder pump and associated pneumatic controller can be used to collect VOC-contaminated water samples that are generally statistically comparable to reference samples when analyzed with the sample method. The system is designed for use in well sampling programs that incorporate low-volume purge methodologies.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_cee.pdf

Environmental Technology Verification Report: Groundwater Sampling Technologies, GeoLog, Inc. Micro-Flo® Bladder Pump Model 57400
Sandia National Lab. for U.S. EPA.
Report No: EPA 600-R-00-075, 46 pp, Aug 2000

The Micro-Flo bladder pump consists of an internal flexible bladder positioned within a rigid stainless steel pump body. The inner bladder is equipped with one-way inlet and outlet valves and passively fills with water when the pump is at depth in the well as a result of the hydrostatic pressure exerted by the surrounding water column. Following the fill cycle, compressed air or nitrogen from a cylinder or compressor at the wellhead drives down through tubing to compress the bladder and drive the water sample up to the surface through a second tube. A controller positioned at the wellhead varies the duration and frequency of the fill/compress cycles to deliver the desired sample flow rate at the wellhead. The bladder design minimizes sample turbulence, which can result in loss of VOC in the sample, and eliminates contact of the water sample with the compressed air or nitrogen used to lift the sample to the surface. The Model 57400 pump tested during this evaluation was the stainless steel and Teflon version, 24 inches long with a 1.66-inch external diameter; weight of 2.5 pounds; volumetric capacity of 225 mL; and an intake stainless steel screen mesh size of 0.25 mm (0.01 inch). The pump can operate at pressures up to 200 psi, which is equivalent to a lift capacity of ~460 feet. A GeoLog Model 5001 pneumatic controller, which controls the flow of compressed nitrogen to the bladder pump, has dimensions of 14.5 x 10 x 9 inches and weighs 15 pounds. Drive air for the bladder pump can be delivered from compressed gas cylinders or from a field-portable gasoline-powered compressor.
The bladder pump tested costs $425 and the controller is priced at $1,295. Teflon-lined polyethylene tubing is also a requirement for most VOC sampling applications and is priced at $2.25 to $2.75 per foot. The results of this verification test show that the Micro-Flo bladder pump and associated pneumatic controller can be used to collect VOC-contaminated water samples that are statistically comparable to a reference method with regard to both precision and comparability with a reference sample. The results of a clean-through-dirty test revealed some sampler carryover of contaminants from an overlying dirty water column into an underlying clean water column. The system is designed for use in well-sampling programs that incorporate low-volume purge methodologies.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_geolog.pdf

Environmental Technology Verification Report: Groundwater Sampling Technologies, QED Environmental Systems, Inc., Well Wizard® Dedicated Sampling System
Sandia National Lab. for U.S. EPA.
Report No: EPA 600-R-00-062, 44 pp, Aug 2000

The Well Wizard is a bladder pump consisting of an internal flexible bladder positioned within a rigid stainless steel pump body. QED Environmental offers a complete line of bladder pumps manufactured with various materials. The Model T1220M and the T1250 tested were essentially the same in design and materials with differences only in pump length--the Model 1220 was 1.04 m and the 1250 was 0.38 m. Both pumps have polytetrafluoroethylene (Teflon) for the bladder material; 316 stainless steel for the pump body, fittings, and intake screen; external diameters of 3.8 cm (1.5 inches); and pump intake stainless steel screen mesh size of 0.25 mm (0.01 inch). Both pumps have a maximum lift capacity of 90 m (300 feet), and flow rates adjustable from less than 100 mL/min to over 5 L/min, depending on pump

lift. The QED Model 400 controller is a microprocessor-based controller and was used to control the flow of compressed nitrogen to the bladder pump. The hand-portable controller has overall dimensions of 18 x 14 x 7.5 inches and weighs 17 pounds. Drive gas for the bladder pump can be delivered from compressed gas cylinders or from a field-portable gasoline- or electric-powered compressor. Costs for the two bladder pumps tested range from $525 to $650 each and the controller is priced at $2,595. Teflon-lined polyethylene tubing is also a requirement for most VOC sampling applications and is priced at $3.30 per foot. The Model T1220M and T1250 differ only in size. The pumps were used interchangeably in the study and their performance results are combined, so this report will refer to the two pump models simply as the Well Wizard sampler. The results of this verification test show that the Well Wizard bladder pump and associated pneumatic controller can be used to collect VOC-contaminated water samples that are statistically comparable to reference samples when analyzed with a common analytical method. The system is designed for use in well-sampling programs that incorporate low-volume purge methodologies.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_qed.pdf

Environmental Technology Verification Report: Groundwater Sampling Technologies, Sibak Industries Ltd. Inc., Kabis Sampler Models I and II
Einfeld, Wayne (Sandia National Labs., Albuquerque, NM); Eric Koglin (U.S. EPA, Las Vegas, NV).
Report No: EPA 600-R-00-054, 50 pp, June 2000

The Kabis Sampler is a discrete-level grab sampler. The two models evaluated in this test operate on the same principle and only differ in size and sampling capacity. Both samplers are constructed of 321 stainless steel. The Model I is 17.4 inches long, 1.75 inches in diameter, and weighs 6.5 pounds. The Model II is 22.3 inches long, 3.65 inches in diameter and weighs 15.5 pounds. Both samplers have a removable top into which a single (Model I) or three (Model II) 40-mL VOA vial(s) are screwed prior to sampler deployment in the well. The sampler is attached to a measuring tape and is manually lowered into the water column. The size and orientation of the inlet and exhaust ports of the sampler are such that it does not fill while it is being lowered down through the water column in the well. When the sampler is held stationary at the desired sampling depth, it begins to fill under hydrostatic pressure. Filling takes about 5 minutes for the Model I and 8 minutes for the Model II. The vials are flushed with about 6 vial volumes prior to the collection of the final vial volume at the end of the sampling cycle. The flush water flowing through the vials spills into the sampler body through spill ports located in the vial holder in the sampler head. Following completion of the fill cycle, the sampler is manually retrieved to the surface and the sample vials removed. The sample is then preserved, if required, and the vials are capped with positive-displacement-type caps that ensure a bubble-free sample. Sampler decontamination is carried out by rinsing the sampler in the field using a 5-gallon bucket of detergent water followed by several deionized or distilled water rinses. Costs for the Kabis samplers are $825 for the Model I and $1,895 for the Model II. The results of the verification test show that the Kabis sampler can be used to collect VOC-contaminated water samples that are generally indistinguishable from a reference method with regard to precision. Sampler recovery, relative to reference samples, was acceptable for four of the six target compounds. Test results indicated low sample recovery with the Kabis sampler for TCE and PCE at high concentrations at both shallow and deep sampling locations.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_sibak.pdf

Environmental Technology Verification Report: Groundwater Sampling Technologies, W. L. Gore and Associates, Inc., GORE-SORBER® Water Quality Monitoring
Prepared by Sandia National Labs., Albuquerque, NM, for U.S. EPA, Las Vegas, NV.
Report No: EPA 600-R-00-091, 53 pp, Oct 2000

The GORE-SORBER module consists of a water impermeable membrane surrounding an adsorbent

material used to collect volatile and semi-volatile compounds in water. When placed in the screened, saturated interval of a monitoring well or piezometer, the waterproof, vapor-permeable membrane collector housing allows for the selective movement of volatile and semi-volatile organic compounds across the membrane onto the adsorbent. The hydrophobic nature of the membrane restricts liquid water transfer across the membrane. Standard (STND) and high water entry pressure (HWEP) membranes were evaluated in this verification test. The sampling modules are compact and completely passive. They are fastened to a string and stainless steel weight, suspended in the well, normally at the mid-screen location, and left in place for 48 hours. Upon retrieval they are placed in airtight containers and overnight shipped to the Gore laboratory. Laboratory analysis options for the sorbent modules include methods for the determination of VOCs, SVOCs, and PAHs, as well as for specific groups of compounds such as fuel hydrocarbons and chlorinated organics. The analyses follow modified EPA SW846 Methods 8260 for VOCs, and 8270 for AVOCs. All analytical services on GORE-SORBER modules were performed at the W.L. Gore & Associates, Inc. laboratory in Elkton, MD. The results of this verification test show that the GORE-SORBER Water Quality Monitoring system can be used to monitor long-term concentration trends of VOCs in monitoring wells. The GORE-SORBER modules are designed and are optimally suited for relatively low-cost VOC concentration trend monitoring and screening. They are well suited for plume edge monitoring to detect general concentration trends. The technology does require the periodic collection and analysis of co-located reference samples to interpret the data from GORE-SORBER module in terms of water concentration.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_gore.pdf

Environmental Technology Verification Report. Explosives Detection Technology: Research International, Inc., FAST 2000™
Oak Ridge National Lab for U.S. EPA, Office of Research and Development.
Report No: EPA 600-R-00-045, 48 pp, Mar 2000

This report describes a demonstration designed to evaluate technologies that detect and measure explosives in soil and water. Only water samples were analyzed with the FAST 2000 in a demonstration conducted at ORNL in 1999. Spiked samples of known concentrations of TNT, DNT, RDX, or HMX ranging from 0 to 25,000 mg/L were analyzed to assess the accuracy of the technology. The results of the water analyses conducted under field conditions by the FAST 2000 were compared with results from reference laboratory analyses of homogenous replicate samples determined with EPA SW-846 Method 8330. The FAST 2000 is based on a displacement assay that uses antibodies and fluorescence as a means of detection. The unit (6 x 15.5 x 16 cm, 2.8 lbs) can be carried into the field easily and plugged directly into a portable PC for on-site data acquisition and analysis. The key elements of the sensor are (1) antibodies specific for the analyte; (2) signal molecules that are similar to the analyte but are labeled with a fluorophore (a cyanine-based fluorescent dye, Cy5) to enable fluorescence detection; and (3) a fluorescence detector. For analysis, the analyte-specific antibodies are immobilized onto a solid support and then saturated with the fluorescently labeled signal molecule, creating an antibody/signal molecule complex. Monoclonal antibodies (NRL's 11B3 TNT and Strategic Diagnostics RDX) are immobilized onto porous membrane supports and saturated with the fluorescent tag. The membrane is inserted into a disposable coupon and placed in the FAST 2000, and the buffer flow is started by a computer command. Once the fluorescence background signal due to unbound Cy5 has stabilized (generally 15-20 minutes), the biosensor is ready for sample injection. If the sample contains the target analyte, a proportional amount of the labeled signal molecule is displaced from the antibody and detected by the fluorimeter downstream. The coupon and membrane can be used for repeated assays. The life of the membrane is dependent upon the number and concentration of positive assays that are run. The reporting limit for both TNT and RDX was 20 mg/L.
http://estcp.hgl.com/documents/techdocs/ETV_Report_RII.pdf

Environmental Technology Verification Report: Explosives Detection Technology -- Barringer Instruments GC-IONSCAN™
Oak Ridge National Lab for U.S. EPA, Office of Research and Development.
Report No: EPA 600-R-00-046, 59 pp, Mar 2000

A demonstration was conducted at ORNL in 1999 to evaluate technologies that detect and measure explosives (TNT, DNT, RDX, and HMX) in soil and water. Spiked samples of known concentration ranging from 0 to ~90,000 mg/kg for soil and 0 to 25,000 mg/L for water were used to assess several performance characteristics. The results of the GC-IONSCAN field analyses were compared with results from reference laboratory analyses of homogenous replicate samples determined using EPA SW-846 Method 8330. The GC-IONSCAN is a fully transportable field-screening instrument that combines the rapid analysis time of ion mobility spectrometry (IMS) with the separation ability of gas chromatography (GC). The instrument can be operated in IONSCAN mode or in GC-IONSCAN mode to detect explosives. The user can switch between the two modes in less than 30 s through the instrument control panel. In the plain IONSCAN mode, samples are deposited on a Teflon filter and thermally desorbed directly to the IMS, permitting the quick screening analysis of explosives residues in 6 to 8 s. In the GC-IONSCAN mode, extracts are directly injected onto the GC column and analysis occurs within 1 to 3 minutes, depending on the type of explosive. The use of the IONSCAN mode permits rapid prescreening of samples with identification of the major constituents of the sample and semiquantitative analysis, while the GC-IONSCAN mode permits full characterization and quantitative analysis of the sample. This technology is capable of reporting quantitative data for all of the Method 8330 analytes. The performance assessment described here is only for TNT and RDX; only a limited amount of data was available for evaluation of the other analytes. The overall performance of the GC-IONSCAN for the analysis of RDX and TNT was characterized as precise and biased low (both analytes) for water analyses, and imprecise and biased (low for RDX and high for TNT) for soil analyses. Reporting limits for the GC-IONSCAN ranged from 0.3 to 10 mg/kg for soil and 25 to 1950 mg/L for water.
http://estcp.hgl.com/documents/techdocs/ETV_Report_Barringer.pdf

Environmental Technology Verification Report: CHEMetrics VVR V-1000 Multi-Analyte Photometer with V-3803 Cyanide Module
James, Ryan; Amy Dindal; Zachary Willenberg; Karen Riggs, Battelle, Columbus, OH.
ETV Advanced Monitoring Systems Center, 50 pp, Apr 2003

The CHEMetrics VVR is a portable multi-analyte direct reading photometer. It uses CHEMetrics self-filling reagent Vacu-vial® ampoules. The cyanide Vacu-vial® test method employs the isonicotinic-barbituric acid colorimetric chemistry. The CHEMetrics VVR uses optical interference filters and a photodiode detector. Test results are displayed in concentration units of mg/L. Vacu-vials® are packaged in individual V-3803 analyte modules, which contain 30 ampoules, two accessory reagent solutions, a 25.0-milliliter (mL) sample cup and instructions. A storage case, dedicated filter, and a coded sealed water blank ampoule are included. Additionally, a test tube is provided for photometer zeroing in situations where samples have background color. To measure cyanide with the CHEMetrics VVR, a 10.0-mL sample is measured in the sample cup, two reagent solutions are added to the sample, the sample is stirred with the tip of the ampoule, and then the tip of the Vacu-vial® is snapped, allowing the sample to be drawn into the ampoule. If any cyanide is present in the water sample, it will react with the chlorine reagent solution to form cyanogen chloride, which in turn reacts with the reagent in the ampoule to form a blue complex in direct proportion to the cyanide concentration. The ampoules are read in the CHEMetrics VVR after a 15-minute color development time. Results are displayed in concentration units of mg/L. The CHEMetrics VVR operates on four AA batteries, has dimensions of 10 inches by 2 inches by 3 inches, and weighs 16 ounces. The list prices are $612.90 for the photometer, $54.10 for the cyanide module, and $20.10 for

the Vacu-vial® refill (which contains 30 ampoules). Accessory solution replenishment packs are available (six bottles/pack).
http://www.epa.gov/etv/verifications/vcenter1-23.htm

Environmental Technology Verification Report: LaMotte 1919 SMART 2 Colorimeter with 3660-SC Reagent System
James, Ryan; Amy Dindal; Zachary Willenberg; Karen Riggs, Battelle, Columbus, OH.
ETV Advanced Monitoring Systems Center, 50 pp, Apr 2003

To analyze cyanide with the LaMotte SMART 2 portable colorimeter, a 10.0-mL sample is measured into a sample vial, and 1.0 mL of reagent is added to the sample with the disposable pipet. The sample is shaken, two other granular reagents are added using the provided scoops, and the sample is shaken again. If any cyanide is present in the water sample, a reaction between cyanide and the reagents added to the sample produces a color change. After a 20-minute color development period, the sample vial is inserted into the LaMotte SMART 2; the cyanide concentration (in ppm) is reported on the digital display. The range of the LaMotte SMART 2 is 0 to 0.50 ppm. It has automatic wavelength selection and is supplied with four sample tubes, an AC adapter, and an instruction manual including test procedures. The dimensions of the LaMotte SMART 2 are 15 x 8 x 5.5 centimeters (6 x 3.25 x 2.5 inches), and it weighs 312 grams (11 ounces). The LaMotte SMART 2 operates at 120V/60Hz or 220V/50Hz. The list price for this unit is $725.00 for the colorimeter and $64.00 for reagents adequate for 50 water samples. The operators found the LaMotte SMART 2 and associated cyanide test reagents easy to use. The instruction manual was clear, and the sample and reagents were easily measured using a disposable pipet and two 0.100-g scoops. LaMotte provided dropper bottles of HCl and NaOH, pH paper, and step-by-step instructions for adjusting the pH of the water sample to between 10.5 and 11.0, which made it convenient for both the non-technical and technical operators to complete the pH adjustment step. The sample jars containing the reacted sample had to be emptied and rinsed between sample analyses. Within one to two minutes, the sample volume could be accurately measured and the reagents added to the sample, which after 20 minutes would produce a color change in the presence of cyanide. If only one sample was analyzed, sample analysis would take approximately 22 minutes, but both operators were able to stagger the start of the color development period every two minutes for subsequent samples, so a typical sample set of 12 analyses took 40 to 45 minutes. Since the color development reaction takes place in reusable reaction vials, additional vials would have to be purchased to conveniently analyze large sample sets.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_1919_SMART.pdf

Environmental Technology Verification Report: Orbeco-Hellige Mini-Analyst Model 942-032
James, Ryan; Amy Dindal; Zachary Willenberg; Karen Riggs, Battelle, Columbus, OH.
ETV Advanced Monitoring Systems Center, 51 pp, Apr 2003

The Orbeco Mini-Analyst Model 942-032 is a portable colorimeter in which a sample and a reagent are mixed and analyzed photometrically to provide a quantitative determination of cyanide in the sample. Model 942-032 uses a photodiode detector, and reports results on a liquid crystal display. The detectable range of cyanide using Model 942-032 is 0 to 0.400 mg/L. First, the samples are preserved to exactly 0.020 M sodium hydroxide. Then, one mL each of the buffer and 1.75 M hydrochloric acid, provided by Orbeco, are added to 100 mL of preserved sample. The pH is then adjusted to be within 6 to 7, as necessary. A capsule of powdered reagent is added to a 10.0-mL aliquot of the pH-adjusted sample, and the sample vial is shaken and set aside for two minutes. In the meantime, a liquid reagent solution is made up in a separate 25-mL vial. This reagent is added to the original sample vial, and the vial is shaken. After a 15-minute color development period, the sample is placed into Model 942-032,

and a cyanide concentration is displayed in mug/L; however, for consistency with the reference laboratory results, all data in this report have been converted to mg/L. Model 942-032 is 6 x 4 x 2 inches and weighs 12 ounces. It operates on four AA batteries and comes with four sample tubes. The list price for this unit is $299.00 for the colorimeter and $67.50 for reagents adequate for ~50 water samples. Analyzed samples containing lethal/near-lethal concentrations of cyanide showed remarkable color development. Sample color changed within five seconds of adding the reagents to bright red and progressed to a dark blue in the next five minutes. The change was much more rapid than for any of the PT samples, which took about 30 seconds to produce a small change in the color of the sample and 15 minutes to reach its analysis color of a clear, light blue. When the samples with lethal/near-lethal concentrations were inserted into Model 942-032 after the full reaction time, the digital readout read "off scale." Even without using the Orbeco Mini-Analyst Model 942-032, the reagent and glass vials would be useful for a first responder seeking to find out whether a toxic level of cyanide is present in a drinking water sample. The presence of such concentrations could be confirmed within minutes by visual observation of the color development process.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_Orbeco_Model_942-032.pdf

Environmental Technology Verification Report: Thermo Orion AQUAfast® IV AQ4000 Colorimeter with AQ4006 Cyanide Reagents
James, Ryan; Amy Dindal; Zachary Willenberg; Karen Riggs, Battelle, Columbus, OH.
ETV Advanced Monitoring Systems Center, 49 pp, Apr 2003

The Thermo Orion AQ4000 is a portable colorimeter in which a water sample and cyanide reagents are mixed and analyzed photometrically to provide a quantitative determination of cyanide. In this test, the AQ4000 was always used in conjunction with Thermo Orion AQ4006 cyanide reagents, which include Auto-Test™ cuvettes. The cuvettes are packaged in individual analyte modules that contain 30 ampoules, a 25-mL graduated cylinder, and instructions. The detectable range of the AQ4000 is 0 to 0.500 mg/L cyanide. A prepared (dechlorinated and pH adjusted) 10.0-mL sample is measured into the graduated cylinder, 5 drops of one reagent and 1.5 mL of another reagent are added to the sample, the sample is stirred with the tip of a cuvette, and then the tip of the cuvette is broken, allowing the sample to rush up into the vial. If any cyanide is present in the water sample, a reaction between cyanide and the reagents added to the sample and those originally present in the cuvette produce a color change. At lethal/near-lethal concentrations of cyanide, the difference in the color development was remarkable. Upon breaking the ampoule in the sample, the color of the sample changed within five seconds to brilliant purple and, after approximately 35 more seconds, to blood red. The AQ4000 is waterproof, 8 inches by 3 inches by 2 inches, and 16 ounces. It operates on four AA batteries. The list prices are $989 for the colorimeter and $32 for AQ4006 refills. Performing analyses under extremely cold conditions negatively affected the performance of the AQ4000 reagents, resulting in decreased color change in the LFM samples. The AQ4000 and AQ4006 cyanide reagents and Auto-Test™ cuvettes were easy to operate. The instructions were clear, and the sample and reagents were easily measured using a graduated cylinder, syringe, and a dropper bottle. The AQ4000 recognized the Auto-Test™ cuvettes when they were inserted, and a 15-minute timer appeared on the digital readout. When analyzing large sample sets, this timer had to be overridden before every sample analysis. While the sample handling and analysis were easy, the pH of each sample had to be adjusted to between 10.5 and 11.0 using NaOH and HCl. This step required the availability of acid and base, pH paper or meter, and some knowledge of pH adjustment.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_AQ4000.pdf

Environmental Technology Verification Report: Thermo Orion Model 9606 Cyanide Electrode With Model 290 A+ Ion Selective Electrode Meter
James, Ryan; Amy Dindal; Zachary Willenberg; Karen Riggs, Battelle, Columbus, OH.

ETV Advanced Monitoring Systems Center, 47 pp, Apr 2003

The Thermo Orion ISE is a solid sensing element containing a mixture of inorganic silver compounds bonded into the tip of an epoxy electrode body. When the sensing element contacts a cyanide solution, silver ions dissolve from the membrane surface. Silver ions within the sensing element move to the surface to replace the dissolved ions, establishing a potential difference dependent on the cyanide concentration in the solution. Upon calibration with solutions of known cyanide concentrations, these potential differences are converted to concentrations and displayed on the digital readout when the ISE is inserted into an unknown solution. Prices and accessories include $742 for the Model 290Aplus ISE meter, $596 for the Model 9606 Cyanide Electrode, and $172 for the plastic carrying case. The 8.08 x 3.26 x 1.90-inch ISE operates on a 9-volt battery. To analyze water samples for cyanide, the ISE first has to be calibrated, after which 0.500 mL of Thermo Orion alkaline reagent is added to 50.0 mL of water sample. The sample is stirred using a magnetic stirrer, and the ISE is lowered into the sample. When a stable reading is attained, the concentration is recorded in mg/L. When analyzing lethal or near-lethal concentrations of cyanide, bias values ranged from 105 to 375%. While the results indicated that a high concentration of cyanide was present, the ISE results were biased high. The ISE was easily transported to the field. While no functional aspects of the ISE were compromised by performing the analyses in the field, bringing the calibration solutions to a temperature similar to the samples required close attention. Calibration could be done with any concentration of cyanide, but solutions do need to be prepared and transported to the field. The pH was easily adjusted before ISE analysis by adding 0.500 mL of alkaline reagent to 50 mL of sample. The battery-powered stirrer would not operate at the slow speeds recommended, which probably increased the variability in the measurements. Sample preparation took 1 to 2 mins per sample, and calibration between 15 and 30 mins. Each sample took approximately 5 mins to attain a stable reading. A typical sample set of 12 analyses plus calibration took approximately 1.5 hrs.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_96_06.pdf

Environmental Technology Verification Report: WTW Measurement Systems Cyanide Electrode CN501 with Reference Electrode R503D and Ion Pocket Meter 340i
James, Ryan; Amy Dindal; Zachary Willenberg; Karen Riggs, Battelle, Columbus, OH.
ETV Advanced Monitoring Systems Center, 46 pp, Apr 2003

The WTW ISE consists of a solid sensing element containing a mixture of inorganic silver compounds bonded into the tip of an epoxy electrode body. In contact with a cyanide solution, silver ions dissolve from the sensor element’s membrane surface. Silver ions within the element move to the surface to replace the dissolved ions, establishing a potential difference dependent on the cyanide concentration in the solution. Upon calibration with solutions of known cyanide concentrations, the potential differences are converted to concentrations and displayed on a digital readout ISE insertion. ISE equipment and prices include $985 for the Ion Pocket Meter 340i and carrying case, $596 for the Cyanide Electrode CN501, and $121 for the electrode stand. The 6.9 x 3.2 x 1.5-inch ISE operates on four AA batteries. The ISE has to be calibrated using calibration solutions of known concentrations of cyanide in 0.100 M sodium hydroxide, then a 50.0-mL sample is stirred with a magnetic stirrer, the ISE is lowered into the sample, and when a stable reading is attained, the concentration is recorded in mg/L. The ISE was easily transported to the field, but the instruction manual was hard to understand, which necessitated vendor consultation for proper assembly and operation. The ISE needed calibration and electrode polishing before every sample set to ensure the most accurate measurements. The calibration concentrations were pre-programmed into the ISE meter so only 0.2-, 2-, 20-, or 200-mg/L calibration solutions could be used. The solutions needed to be prepared and transported to the field. No pH adjustment was necessary once the sample was preserved to a pH greater than 12.0. The battery powered stirrer would not operate at the slow speeds recommended. The ISE was calibrated with 3 calibration solutions before performing any sample analyses. Calibration took between 15 and 30 mins. Once the ISE was calibrated, each

sample took approximately 5 mins to attain a stable reading. A typical sample set of 12 analyses plus calibration took approximately 1.5 hrs.
http://www.epa.gov/etv/pdfs/vrvs/01_vr_wtw_cn501.pdf

E-SMART® Threat Agent (E-SMART® TA) System
Fisher, Rodney A. (AFRL/MLQL (TRW), Tyndall AFB, FL); Roger Schlicht (General Atomics, San Diego, CA).
TRB 2003 Annual Meeting, Transportation Research Board, CD-ROM, 31 July 2002

The Environmental Systems Management, Analysis and Reporting neTwork (E-SMART®) was developed as a system of smart sensors, active controls, data acquisition, data reduction, and adaptive decision software to sample, analyze, and report on environmental contamination and cleanup activities on an installation. The prototype system was installed and demonstrated and is currently operating, at Tinker AFB, OK. The system is based on ANSI/EIA-709.1-A networking protocol originally developed for building environmental systems automation and process control. Sensor interfaces have been developed which allow E-SMART to network off-the-shelf commercial "smart" or "dumb" environmental sensors and/or new innovative sensors. The network architecture can support communications media connections via wire, radio frequency (rf), fiber optics, etc. The system has been on line at Tinker AFB since 1998, and originally consisted of about 100 sensors with a present array of 30 sensors, measuring up to six variables each. Recent development has begun to expand the E-SMART sensor suite to include threat agent sensors, e.g., E-SMART Threat Agent (E-SMART® TA). This current effort is integrating on-line chemical and biological sensors and monitoring systems to demonstrate an E-SMART TA system to improve/enhance protection, warning, and response. The emphasis is on maximizing adaptability and flexibility by accepting the widest possible variety of toxic industrial chemical/material and chemical/biological agent sensors (current, emerging, and future), responding to a wide range of deployment/employment requirements, incorporating existing and future analysis models, and providing data sharing and interoperability across all users, DoD and civilian.
http://www.wsdot.wa.gov/ppsc/research/TRB_Special/TRB2003-000501.pdf

Evaluating DNAPL Source and Migration Zones: M-Area Settling Basin and the Western Sector of A/M Area, Savannah River Site
Jackson, Dennis G., Jr.; Brian B. Looney, Westinghouse Savannah River Company, Aiken, SC.
Report No: WSRC-TR-2001-00198, 52 pp, Jun 2001

Detailed characterization data collected near the M Area Settling Basin provide a technical basis for understanding and addressing DNAPL at this site. The data and interpretation confirm general DNAPL migration and accumulation behaviors, as well as delineate specific regions that are most important to cleanup using source remediation methods, such as steam flushing. Key elements in the interpretation included the use of three-dimensional imaging, screening criteria to consolidate data from different subsurface sampling media (solid, liquid, and gas), and relating the real-world data to a simple conceptual model of expected behaviors. To support the work, the researchers developed an informative new type of figure that integrates and posts the data in three dimensions, along with information on geology on a single page. The integration device has been used to develop various source cleanup scenarios.
http://www.srs.gov/general/pubs/fulltext/tr2001198/tr2001198.pdf

Evaluating Site Remediation Success Using a Sensitive Biochemical Indicator in Fish
Elskus, Adria (PI), Univ. of Kentucky.

USGS Water Resources Research/National Institutes for Water Resources (NIWR), State Program
Project No 2002KY1B, 2002 - 2003

Significant levels of environmental PCBs in Kentucky have led to the posting of fish advisories in several Kentucky waterways. The focus of the present study is Kentucky's Town Branch/Mud River (TB/MR) system, a PCB-contaminated site currently under remediation. This project addresses several needs: 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. Currently, there is no information on whether exposure to PCBs in the TB/MR system produces sublethal effects in fish populations in that system, and/or whether present remediation efforts are reducing such effects. An enzyme, CYP1A, is strongly and rapidly induced in animals exposed to toxic organic pollutants, including PCBs. The researchers hypothesize thatCYP1A levels in TB/MR resident fish reflect organic contaminant levels at their site. Project objectives are to determine if CYP1A levels in resident fish in the TB/MR system reflect expected habitat contamination level and to use CYP1A levels in caged fish to evaluate the effectiveness of cleanup efforts in the TB/MR 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.

Evaluation of the Partition Interwell Tracer Technique for Possible Characterization of DNAPL Pools
Moreno-Barbero, Elena; S. Saenton; D. Dai; T. Illangasekare, Colorado School of Mines, Golden.
GSA 2002 Denver Annual Meeting, 27-30 October 2002. Geological Society of America, Paper No. 83-14

The Partition Interwell Tracer Technique (PITT) developed in the petroleum industry has been adapted by environmental engineers to characterize the amount and location of subsurface DNAPLs. PITT uses a suite of chemical tracers to detect the presence of free-phase NAPLs and provide an estimate of its effective or average NAPL saturation. Though this technique has been used with some success in a large number of sites there are still some limitations under complex entrapment morphologies resulting from aquifer heterogeneity. In existing methods, PITT data are analyzed assuming local equilibrium exists between phases. This assumption may be true for low saturations, but not in cases of high DNAPL saturation (pools) that could be expected at heterogeneous field sites. The ground water flows around pools due to the reduced aqueous relative permeability caused by DNAPL entrapment. Bypassing water may reduce the contact between the tracer solution and the NAPL and tracer diffusion in the oil phase. If these conditions are not recognized, NAPL saturation will be underestimated.

Researchers are investigating possible causes for underestimation of saturation by PITT for different entrapment scenarios. The definition of a "pool" has to be evaluated to look closely at the processes that occur within the source zone. Based on controlled experiments that involve the placement of the source zone in a test tank and evaluating tracer breakthrough curves under different flow and pool conditions, an analysis and understanding of causes for this estimation error can be performed. This paper presents the preliminary results from experimental investigations conducted in one-dimensional columns and two-dimensional dissolution cells to obtain a fundamental understanding of how tracers interact with DNAPL pools. The experimental data in conjunction with model analysis are used to make a determination of PITT as a viable technique for characterization of DNAPL source zones.

Fabrication and Evaluation of an Oxygen Microelectrode Applicable to Environmental Engineering and Science
Lu, R.; T. Yu.
Journal of Environmental Engineering and Science, Vol 1 No 3, p 225-235, 2002

This paper introduces the theory, fabrication procedure, and evaluation method of an oxygen microelectrode. The combined oxygen microelectrode with small-tip diameter (15-20 mm) was evaluated by subjecting it to a polarization voltage of -0.8 V and calibrating against known dissolved oxygen concentrations from zero to air saturation. The results of the evaluation demonstrated the success of the fabrication procedure. The microelectrode had a fast response time (<2 s), stable reading with good calibration linearity (R2=1), low residual current signal (6 pA), and low stirring effect (4%). No electromagnetic interference was observed under either laboratory or field conditions. The combined oxygen microelectrode can be used for in situ measurement of dissolved oxygen in wastewater biofilms in the field.

Factors Affecting cis-Dichloroethene and Vinyl Chloride Biological Transformation under Anaerobic Conditions
Spormann, Alfred M. (Stanford Univ., Stanford, CA); A.M. Cupples; J.A. Mueller; G. Meshulam-Simon; P. McCarty.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 21, 2002

Several molecular tools for detecting biological reductive dehalogenation in situ were developed and tested. A mixed culture degrading vinyl chloride (VC) and cis-1,2-dichloroethene at high rates was used as model system. A specific competitive PCR (cPCR) assay targeting 16S rDNA was developed to enumerate a *Dehalococcoides*-like microorganism in this culture. The cPCR assay enabled the investigation of kinetic parameters for this organism and revealed the distinctive capabilities of this bacterium to conserve energy during growth from VC dehalogenation. Additionally, fluorescence in situ hybridization (FISH) was performed by applying eubacteria and specific *Dehalococcoides* 16S rRNA-targeted probes to the culture. The method was inefficient for monitoring the *Dehalococcoides*-like microorganism in situ due to low signal intensity, probably a result of low ribosome content and the cell morphology of the organisms. The development of a gene probe for VC reductase is in progress. SERDP funds this research under project CU-1169.

Fast Mineral Identification Algorithm for Reflectance Spectra of Iron Oxide, Iron Oxyhydroxide and Iron Sulfate Minerals
Montero Sanchez, I.C.; G.H. Brimhall, Univ. of California, Berkeley.
Summit 2000: Annual Meeting of the Geological Society of America, Reno, Nevada. Abstracts with Programs, Vol 32 No 7, p A-180, 2000

An identification algorithm for reflectance spectra covering the range from 0.35 to 2.5 micrometers (ultraviolet, visible, and infrared light range) was developed for fast identification of minerals, such as iron sulfates, soluble sulfate salts, oxides and oxyhydroxides. The algorithm was designed to work with data from a portable reflectance spectrometer, in coordination with a DGPS/laser digital mapping system, to create surface mineralogy maps contemporaneously with surveying. The algorithm is based on the characterization of the broad absorption band caused by electronic transitions of the Fe3+ ion in iron minerals. Subtle features in the shape of this broad band caused by structural and chemical properties are used to identify secondary iron minerals commonly found in acid mine drainage (AMD) environments such as copiapite, jarosite, schwertmannite, and goethite. Preliminary testing of this algorithm with laboratory and field acquired spectra of natural samples shows it to be a valid method to compare mineral features in reflectance spectra and characterize the surface mineral distribution of abandoned mine sites, facilitating the evaluation of such sites for the occurrence of AMD.

Fenceline Monitoring of Hazardous Air Pollutants by Automatic GC
Driscoll, John N.; Timothy Bishop, Process Analyzers, LLC, Walpole, MA.
PITTCON 2001, Abstracts, p 1252, 2001

The use of continuous monitors for fenceline monitoring occurs in the United States when a significant release (leak) occurs from a major source or when there is considerable public pressure or concern on the part of local environmental authorities. For fenceline monitoring, measurements have to be made at ppb or even sub-ppb levels, which require either a sensitive detector such as a photoionization detector (PID) or electron capture detector (ECD) and/or a concentrator (thermal desorber). The measurements can be done in a mobile van or in fixed stations that surround the plant. The authors discuss some of the difficulties involved in calibrating and monitoring ppb levels in the field, along with the type of accuracy and reproducibility achieved.

Field Air Analysis with SPME
Koziel, Jacek (Texas A&M University, Amarillo); Fabio Augusto; Claudia Zini; Mingyu Jia; Abir Khaled; Japheth Noah; Janusz Pawliszyn.
PITTCON 2001, Abstracts, p 201, 2001

Solid-phase microextraction (SPME) presents many advantages over conventional analytical methods by combining sampling, pre-concentration, and direct transfer of the analytes into a standard gas chromatography (GC). SPME can be used in field air sampling and on-site analysis. On-site analysis with SPME allows for immediate assessment of sampled air, increases sample throughput, requires no sample preservation, and allows "hot spot" sampling for many VOCs. This paper presents an overview of the current methods for quantitative air sampling and analysis with SPME using both grab and time-weighted average modes for short- and long-term exposure assessment. New developments in spot, rapid, and long-term sampling will be illustrated with field data from indoor air surveys, trace biogenic and aroma studies, and screening for particulates in vehicle exhaust. Advantages and challenges associated with field air analysis with SPME also will be discussed.

Field Evaluation of an Electrochemical Probe for In-Situ Determination of Heavy Metals in Ground Water
Herdan, J.; R. Feeney; S.P. Kounaves; A.F. Flannery; C.W. Storment; G.T.A. Kovacs; R.B. Darling.
Environmental Science & Technology, Vol 32 No 1, p 131-136, 1998

This paper describes the use of an electrochemically based probe for in situ determination of heavy metals in ground water. The in situ probe, consisting of a microlithographically fabricated iridium ultramicroelectrode array sensor (UMEA), a custom-built miniaturized potentiostat and microcontroller, is connected to a laptop computer for control and data acquisition. A proof-of-concept field demonstration of the probe was conducted at a metals-contaminated landfill site at Hanscom Air Force Base in Bedford, MA. Using the electroanalytical technique of square wave anodic stripping voltammetry (SWASV), the sensor measured both the labile and total pH <2 forms of copper, lead, cadmium, and zinc at parts per billion. The field measurements were compared to laboratory-based electroanalytical measurements and to EPA Method 200.7 ICP analysis. The results show in situ electroanalytical measurements of labile metal species to be feasible, providing a rough estimation of metals concentrations and trends. The field results agree to within an order of magnitude with the laboratory determinations, demonstrating that such electroanalytical-based devices can provide initial, rapid, low-cost screening of sites contaminated with heavy metals.

A Field Sampling Method Using Bubble Stripping for Dissolved MTBE and Hydrogen in Ground Water
Kampbell, Don Henry (U.S. EPA, Ada, OK); Dan M. McInnis.
PITTCON 2001, Abstracts, p 1362, 2001

A bubble-stripping procedure was applied at field sites by filling a sample cell with well water and then charging it with 20 mL of air to produce a head space over the water, the "bubble" into which any gases in solution will partition. A peristaltic pump moves the well water through the cell such that a stream of water flows through the head space and produces agitation in the aqueous phase. Pumping continues until equilibrium is established between the aqueous phase and the head space. Gas chromatographic analysis determines gaseous concentration in the head space, which allows concentration in solution to be calculated using Henry's law. The Bubble Stripping Method was applied in the laboratory to determine carbon dioxide, vinyl chloride, and MTBE concentrations in aqueous solution. Employing a specially designed apparatus to provide an optimal solution flow rate through the cell of 300 mL/minute, the stripping process was complete within ten minutes.

Field Screening Method for Perchlorate
Thorne, Philip G., Applied Research Associates, Inc., South Royalton, VT.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 34, 2002

A simple, reliable, and inexpensive colorimetric method for perchlorate in water has been developed and tested with surface water, well water, and bioreactor effluent. The detection limit is 1ug/L. A 0.5 L sample is passed through a solid-phase extraction cartridge that has been conditioned with a perchlorate-specific ion-pair reagent. Perchlorate is retained, as well as small quantities of chlorate and major ions. A rinse step removes the interferences and the perchlorate is eluted into an ion-pairing dye in a 15mL test tube. A layer of xylene is added, the tube is shaken, and the dye-pair extracts into the xylene that separates into a layer lying in the beam of a standard portable spectrophotometer. Results from nearly 100 well water and bioreactor samples show excellent agreement with EPA Method 314 over the range of 1-300 ug/L (slope = 1.15, R^2=0.96). Some false positives were encountered in some wells. The method is being adapted to an automated on-line monitor that will be operational and in field trials by next June.

Field tests of a DNAPL Characterization System Using Cone Penetrometer-Based Raman Spectroscopy
Rossabi, J.; B.D. Riha; J.W. Haas III; C.A. Eddy-Dilek; A.G. Lustig Kreeger; M. Carrabba; W.K. Hyde; J. Bello.
Ground Water Monitoring and Remediation, Vol 20 No 4, pp 72-81, 2000

This paper describes the technology and results obtained from several field trials of cone penetrometer-based Raman spectroscopy at Savannah River waste sites. The method and results shown in the paper represent the first in situ direct measurement of DNAPL (PCE and TCE) in the subsurface.

Fourier Transform Infrared Spectroscopy in Continuous Emission Monitoring: An Update
Karfik, Vlastimil (ABB Automation Products GmbH, Frankfurt, Germany); Allan J. Rilling; Joseph W. Worthington.
PITTCON 2001, Abstracts, p 1256, 2001

This paper reports on the experience gained from eight years of monitoring stack emissions with FTIR spectroscopy, as well as the operating principle and construction of the FTIR-based Continuous Emissions Monitoring System (FTIR-CEMS). FTIR spectrometers designed for industrial environments can providing measurements of up to 10 chemical compounds simultaneously, while the number is extendable up to 30 ef measurement components measured simultaneously. The FTIR spectrometer with heated sample cell allows measurement of stack gas "as is", thus avoiding any distortion of analytical results for water-soluble compounds like HCI, HF, and NH3. The authors present statistics for the measurement of extremely low ppm levels of pollutants like HCI, SO2, CO, NO, NH3, and HF, even in the presence of large amounts of water vapor. The results obtained from the operation of more than 240 FTIR continuous emissions monitoring systems throughout the world are discussed.

Geophysical Investigations of Near-Surface Mine Sites in Northern West Virginia
Fahringer, Peter E., Master's thesis, West Virginia University, Morgantown. 139 pp, 1999

The use of geophysical techniques to characterize surface and underground coal mine sites, monitor remedial efforts, and provide additional subsurface information is evaluated in this study. Terrain conductivity (EM31 and EM34) grids as well as resistivity and magnetic profiles were collected at a mine spoil and two abandoned underground mine sites in northern West Virginia. Data were contoured and modeled using computer software to evaluate various subsurface conditions. Geophysical data were used in conjunction with hydrologic, geochemical, and borehole data previously collected to develop a better understanding of subsurface conditions at each site. At both underground sites, near-surface features (a gas transmission line and a fly-ash pile) partially concealed deeper (~15 m and ~25m) targets and limited the effectiveness of geophysical techniques used. Results from the surface mine site demonstrate the ability of the terrain conductivity technique to locate post-treatment sludge and lime slurry plumes in a mine-spoil at various depths, from 4.5 to 25.5 meters. The metal-rich sludge and alkaline slurry appears as an anomalously high conductivity region. High conductivity zones extending downgradient from sludge-filled and slurry-filled pits at the surface suggest the terrain conductivity method can be used to identify preferred flow paths in mine spoil as well. Because terrain conductivity data can be collected rapidly and interpreted easily, it is the most promising of the techniques used in this study. The results illustrate the potential benefits of geophysical surveys to mine site evaluation, as well as some limitations. Work is continuing to better define the role of geophysics in mine site characterization in the region.
http://etd.wvu.edu/templates/showETD.cfm?recnum=1087

Geophysical Monitoring System Installed on EPA's Gilt Edge Superfund Site
Subsurface Topics: INEEL Subsurface Science Initiatives, Vol 4 No 1, Mar 2003

A unique geophysical monitoring system will soon be operational at the Gilt Edge Mine Superfund site in South Dakota to monitor the performance of the site's huge cap in real time. The 258-acre site was developed in 1986 in South Dakota's Black Hills and abandoned in 1999 after its operator became insolvent. The site has three open pits containing 150 million gallons of acidic, metal-laden water; a large cyanide heap leach pad; and an acid-generating rock dump. The rock dump—~20 million cubic yards of sulfidic waste rock and spent heap-leach ore material--covers 62 acres. The monitoring system contains an array of 600 stainless steel electrodes connected by 18-gauge copper wires to teflon jacks with a compression fitting. The electrodes had to be in place before construction of the 15-foot thick composite cap. Monitoring instruments were installed in four well pairs drilled into the rock dump and fitted with thermocouples, electrodes, gas ports, tensiometers, and lysimeters. The $23 million cap consists of a geotextile overlaid with soil to reduce acid generation by preventing infiltration of water and oxygen, with a geophysical monitoring system to identify cap failures and pinpoint sources of incoming fluids. The electrical surface resistivity system spans the entire cap over the waste rock dump,

with more than 600 electrodes spaced at 25-foot intervals. The borehole monitoring instruments are placed in four pairs of wells that extend 180 feet to the bottom of the waste rock dump. One well in each pair contains electrodes and thermocouples placed at 10-foot intervals from the top to the bottom of the well. The other well contains tensiometers, suction lysimeters and gas ports at varying intervals. The array of instruments will indicate how the cap performs and how the geochemical environment of sulfide-rich tailings changes over time. Contact: Gail Heath, 208-526-7009, heatgl@inel.gov, or Ken Moor, 208-526-8810, ksm@inel.gov.
http://subsurface.inel.gov/information/newsletter/Vol4Iss1/giltedge.asp

Geophysics in Engineering Investigations
McDowell, P.W.; R.D. Barker; A.P. Butcher; M.G. Culshaw; P.D. Jackson; D.M. McCann; B.O. Skipp; S.L. Matthews; J.C.R. Arthur.
Geological Society Engineering Geology Special Publication No 19, 252 pp, 2002

The advantage of a geophysical survey is that it enables information to be obtained for large volumes of ground that cannot be investigated by direct methods due to cost. The applications of geophysics in the characterization of contaminated land are still developing, but have great potential to identify the distribution and migration of pollutants in the ground and ground water. This report is published in cooperation with the Geological Society and presents a logical guide through the process of using geophysical investigation methods in site construction. It explores the roles of geophysical methods and provides background for geophysics as an investigative tool. The procurement, management and reporting frameworks for geophysical investigation are set out, and the underlying science and current practices of the main techniques are explained, as well as the processes of data acquisition, handling, and presentation. The different targets determinable by geophysical methods are considered in separate sections for geological, geotechnical, geoenvironmental, and structural engineering applications. The report concludes with recommendations for practice.

Geostatistic Mapping of Arsenic, Manganese and Iron Contamination Risk in the Port of Santana, Amapa, Brazil
Barbosa Queiroz, Joaquim Carlos (Univ. Estadual Paulista, Brazil); J.R. Sturaro; P. Setti Riedel.
IAMG2001: Annual Conference of the International Association for Mathematical Geology, 6-12 September 2001, Cancun, Mexico. 16 pp, 2001

An annealing simulation was used to carry out a probabilistic evaluation of arsenic, manganese, and iron contamination in the port of Santana, Amapa, Brazil. The probabilistic approach explicitly recognizes the uncertainty in contaminant concentrations at unsampled locations, hence the area and boundaries of contaminated zones are uncertain. Specific values of these quantities can be obtained through the specification of a target probability or level of risk. The site is discretized into an array of blocks with known size and shape, and a simulated value of contaminant concentration obtained for each block. Fifty realizations were generated of the contaminant concentrations where all matched reasonably to the same statistics (histogram, semivariogram) allowing the assessment of the uncertainty about the spatial distribution of the contaminants. The choice of the probability cutoff was determined by tolerable maxima established by an agency of the Brazilian government, but other established criteria can be used. The simulated maps can be used as input into transfer functions such as health and remediation costs.
http://www.kgs.ukans.edu/Conferences/IAMG/Sessions/G/queiroz.html

Haloprobe: Direct Push Tool with Highly Specific Chlorinated Response

Gillispie, Gregory D. (Dakota Technologies, Inc., Fargo, ND); Stephen Lieberman; Randy St. Germain; Paul Jarski; Steve Adamek.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Technical Abstracts, p 48, 2002

DoD requires faster, cheaper, and more accurate procedures to characterize and monitor VOCs in the subsurface, particularly chlorinated solvents in the form of dense non-aqueous phase liquids (DNAPLs). With SERDP funding from 1998-2001, Dakota Technologies, Inc. (DTI) developed the Haloprobe, a halogen specific detector designed to work in concert with a membrane interface probe (MIP). The Army Corps of Engineers conducted an ESTCP demonstration that proved the MIP offers efficient and automated sampling of the soil formation for VOCs. More recent work allows chemical detection with the Haloprobe to be performed downhole with continuous measurements. The Haloprobe can be deployed with a cone penetrometer or similar direct push rig, but is not compatible with percussion delivery. It exhibits a highly specific response to halogenated species; the selectivity for TCE and PCE relative to petroleum hydrocarbons is better than 5000:1. The most profound benefit of the Haloprobe for pinpointing DNAPLs source terms is that it improves spatial resolution from feet, as is typical for soil borings, to inches. Moving the detector downhole also eliminates issues of transmission losses or fouling of transfer lines. When desired, the Haloprobe can be readily reconfigured to a high sensitivity mode for mapping dissolved-phase concentrations; the limit of detection in the high sensitivity mode is better than 100 g/L PCE or TCE in the saturated zone. Recent studies at DTI have shown that the Haloprobe response to various chlorinated species is linearly proportional to the number of chlorine atoms per molecule, which allows presentation of the results in a total chlorine content format. This presentation illustrates the features of the Haloprobe, presents lessons learned from the first two of three planned deployments for ESTCP, and discusses technology transfer status to the government and commercial sectors.

Handheld Analytical Biosensors
Laing, Lance G. (Regenesis Bioremediation Products, Belmont, MA); D. Weinkle; S. Koenigsberg.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 31, 2002

Biosensors are at their most fundamental level small binding reactions where the interacting species are a target, specific detector, and signal of interaction. Ions and small molecules such as metals and organics have been challenging to qualify and quantify at low toxicity levels set by the federal government, even with the most sophisticated of laboratory instruments. With new biotechnologies currently being developed, these limitations can be overcome at considerably reduced cost. In a novel application of surface plasmon resonance and allosteric biopolymers, Regenesis has developed a biosensor platform that addresses the needs for quantitative analysis in a palm-sized device with broad applications for environmental issues. The platform is very sensitive for arsenic species and can be applied to many other analytes where sub-ppb sensitivity, selectivity, and highly accurate quantitative analyses are required. This presentation discusses the technical accomplishments for the new biotechnology and device for analyte binding, specific detection, and signaling, including the scientific and engineering aspects of the platform. In addition, other detection and quantification programs planned for 2002-2003 are described. The long-term goal is to multiplex the system to provide a suite of results at one time in the field as an alternative to expensive and time-delayed results from off-site laboratory services.

HazMat Card Offers Low Cost Hazardous Materials Detection
Rothery, Grainne.
The Alchemist, 17 July 2003

A user-friendly, wearable card that helps emergency responders to detect chemical agents has recently gone into commercial production in West Virginia. The vinyl and paper HazMat Smart-Strip, which measures approximately 9 cm by 7 cm, contains eight reagent squares, each of which reacts to the presence of a corresponding chemical by changing color. The product can detect chlorine, fluoride, nerve agents, oxidizers, arsenic, hydrogen sulfide, and cyanide in both liquid and aerosol form. The HazMat Smart-Strip was developed by Mike Reimer, a full-time fire-fighter and hazardous materials technician, as an alternative to the practice whereby responders attach pieces of pH paper and M8 litmus paper to their clothing. Reimer set up Safety Solutions, Inc. and has been developing his technology in partnership with the National Technology Transfer Center's Emergency Response Technology program since 2001. Safety Solutions now has 14 patents on the product internationally. The HazMat Smart-Strip attaches to the user's clothing with adhesive backing or a clip. The eight reagents are self-contained and are activated by removing a protective covering. Once activated, the card is operational for 12 hours or until it is exposed to one of the eight substances. All of the reactive components have been directly integrated within the layers, thus eliminating the need to apply additional strips of reagents or buffer solutions. The color developing indicator layer contains a chemical-sensitive paper that changes color when one of the eight categories of chemicals is present. Electronic chemical detecting monitors can cost between $2000 and $50 000, have high maintenance costs, and require extensive training to use; the Smart-Strip requires very little training and costs $20 per unit. The HazMat Smart-Strip is being used for remote detection when affixed to EOD robots.

Heavy Metal Analysis and Speciation and Biosensor [Patent Pending]
Contact: John R. Snyder, 208-526-9812, snydjr@inel.gov.
Idaho National Engineering and Environmental Laboratory, INEEL Technologies Available for Licensing: INEEL No. B-258, 2003

The invention is a colorimetric method for determination of a metal, such as trivalent chromium (Cr(III)), in pure or mixed metal samples. A simple modification allows determination of the valence state of the metal, e.g., hexavalent chromium (Cr(VI)), as well as Cr(III).

High Resolution Seismic Reflection to Characterize and Plan Remediation at Hazardous Waste Sites. ESTCP Cost and Performance Report
U.S. DoD, Environmental Security Technology Certification Program (ESTCP). 40 pp, October 1999

This report presents cost and performance data for the three-dimensional (3-D) seismic reflection survey technique used to generate high-resolution 3-D imaging of subsurface geologic, hydrogeologic, and DNAPL contaminant source areas at four DoD sites: Letterkenny Army Depot near Chambersburg, PA; Alameda Naval Air Station, Alameda, CA; Tinker Air Force Base, Oklahoma City, OK; and Allegany Ballistics Laboratory, Mineral County, WV. At Allegany Ballistics Laboratory, only geologic predictions (not DNAPL) were investigated. The objective of the project was to verify that the 3-D seismic reflection survey is a viable technique for rapidly and effectively performing DNAPL source delineation and high-resolution site characterization. This objective would be met if 90% of the predictions for DNAPL contamination generated from the 3-D seismic survey results were verified to be correct, based on analysis of ground-water samples taken from within the surveyed regions. As a secondary objective, the surveys also demonstrated high-resolution site characterization by using the seismic output to interpret the depth to bedrock and the depth to fracture zones at several of the sites. Seismic reflection imaging is based on the principle that acoustic energy (sound waves) will bounce, or "reflect," off the interfaces between layers within the earth's subsurface. These interfaces are subsurface anomalies that provide possible pathways and traps for DNAPL. It was believed that interfaces between the DNAPLs and surrounding materials can cause a reflection anomaly recognizable with this seismic technique. A 3-D seismic survey uses multiple points of observation generated from a grid of geophones

and seismic source impact points deployed along the surface of the site. The result is a volume, or cube, of seismic data sampled from a range of different angles (azimuth) and distances (offset). The data provide high-resolution, distortion-free representation of the subsurface.
http://estcp.hgl.com/documents/techdocs/199601.pdf

Highly Sensitive and Selective Surface Plasmon Resonance Sensor for Detection of Sub-ppb Levels of Benzo[a]pyrene by Indirect Competitive Immunoreaction Method
Miura, Norio; Makoto Sasaki; K. Vengatajalabathy Gobi; Chiwa Kataoka; Yukihiro Shoyama,
Biosensors and Bioelectronics, Vol 18 No 7, p 953-959, Jul 2003

The authors report the development of a surface plasmon resonance (SPR)-immunosensor for detection of benzo[a]pyrene (BaP). The immunosensor is based on a model BaP-hapten compound, a BaP-bovine serum albumin conjugate (BaP-BSA), and an anti-BaP-BSA monoclonal antibody. BaP-BSA conjugate is immobilized on a gold thin-film sensor chip by means of simple physical adsorption. An anti-BaP-BSA antibody in contact with the BaP-BSA conjugate immobilized sensor chip causes an increase in the incident angle of the sensor chip. The presence of BaP in the analyte solution inhibits the binding of the anti-BaP-BSA antibody with surface-immobilized BaP-BSA conjugate. The sensor has a response time of ~15 minutes in a concentration range of 0.01 to 1000 ppb. Because the antibody anchored to the sensor chip by antigen-antibody binding is removed on treatment with a pepsin solution , the SPR sensor chip can be reused more than 20 times with little decrease (<7%) in response.

HPLC Determination of Sulphonated Melamines-Formaldehyde Condensates (SMFC) and Lignosulphonates (LS) in Drinking and Ground Waters
Pojana, G.; C. Carrer; F. Cammarata; A. Marcomini; C. Crescenzi, Univ. of Venice, Venezia, Italy.
International Journal of Environmental Analytical Chemistry, Vol 83 No 1, p 51-63, Jan 2003

New separation/detection procedures by reversed-phase HPLC coupled with UV and fluorescence detection have been developed for the determination of organic admixtures of the sulphonated melamines-formaldehyde condensates (SMFC) and lignosulphonates (LS) type in drinking water, ground water, and leachates. The method reaches detection limits in the 0.05 to 0.3 ug range. A sample extraction/enrichment method based on solid-phase extraction (SPE) has been developed for SMFC based on polystyrene-divinylbenzene (PS-DVB, Envichrom-P) resin as a sorbent. The analytical procedures were applied to the determination of SMFC and LS in commercial blends, drinking and ground waters, industrial effluents, and liquors from leaching tests.

In Situ Real-Time Trace Element Monitoring in Aquatic Systems Using a Submersible Voltammetric Probe
Tercier-Waeber, Mary Louise (Univ. of Geneva); Jacques Buffle; F. Confalonieri; G. Riccardi; A. Sina; F. Graziottin; G.C. Fiaccabrino; M. Koudelka-Hep.
PITTCON 2001, Abstracts, p 649, 2001

This presentation discusses a Voltammetric In-situ Profiling (VIP) System based on advanced microprocessor and telemetry technology and developed to allow real-time monitoring of trace elements in natural aquatic systems down to 500 meters depth. The system combines high sensitivity, speciation capability, and sample integrity with robustness, ease of handling, and flexibility. The heart of the submersible voltammetric probe is a gel-integrated microsensor array specially developed to enable continuous, reproducible, and reliable measurements of analytes in complex media without physical and chemical interferences of the test solution. The VIP system can directly measure in situ the mobile fractions of Cu, Pb, Cd, and Zn at the ppt level, as well as Mn and Fe at the ppb level. The presentation summarizes the characteristics of the probe and microsensor and illustrates the VIP system performance with examples of in situ applications in sea, lake, and ground water. Work is under way to extend the application of the VIP System for direct in situ speciation of trace elements.

Innovative and Rapid Air Quality Monitoring Using Electronic Nose
Schmitt, Vincent O. (Alpha M.O.S. SA, Toulouse, France); T.J. Braggins; Jean-Francos Chauvet.
PITTCON 2001, Abstracts, p 738, 2001

A new air quality monitoring approach based on Electronic Nose FOX 4000 has been investigated to study differences between the effluent air from two meat rendering plants before and after biofiltration and differences between serial dilutions of rendering plant effluent air. The results showed good discrimination among all samples. The relative distances of the after-biofilter samples from the clean-air reference sample suggest that the biofilter used at Plant B was more effective in removing volatile chemicals from the plant's effluent air than the biofiltration system of Plant A. This finding was independently confirmed. These results indicate that Electronic Nose technology is an appropriate tool to monitor rendering plant effluent air output and biofilter performance and might be useful for other environmental air compliance monitoring applications.

Innovative Technology Verification Report: Sediment Sampling Technology, Art's Manufacturing and Supply, Inc., Split Core Sampler for Submerged Sediments
Tetra Tech Environmental Management, Inc., Chicago, IL.
Report No: EPA 600-R-01-009, NTIS: PB2003-106592, 133 pp, Dec 1999

In April and May 1999, EPA conducted a field demonstration of the Split Core Sampler. The performance and cost of the Split Core Sampler were compared to those of two conventional samplers (the Hand Corer and Vibrocorer), which were used as reference samplers. Primary objectives for this demonstration included evaluating the samplers ability to (1) consistently collect a given volume of sediment, (2) consistently collect sediment in a given depth interval, (3) collect samples with consistent characteristics from a homogenous layer of sediment, (4) collect a representative sample from a clean sediment layer below a contaminated sediment layer, and (5) be adequately decontaminated. Additional primary objectives were to measure sampling time and estimate sampling costs. Secondary objectives included (1) documenting the skills and training required for sampler operation, (2) evaluating the samplers ability to collect samples under a variety of site conditions, (3) assessing the samplers ability to collect an undisturbed sample, (4) evaluating sampler durability, and (5) documenting the availability of the sampler and its spare parts. To ensure data usability, data quality indicators for precision, accuracy, representativeness, completeness, and comparability also were assessed based on project-specific QA objectives.
http://www.epa.gov/ORD/SITE/reports/600r01009.htm

An Integrated Approach to Screening of Abandoned Mines for Remediation: Digital Field Mapping, IR Spectrometry and Time-Series Water Chemistry
Takagi, T.K.; I.C. Montero Sanchez; G.H. Brimhall, University of California, Berkeley.
IAMG2001: Annual Conference of the International Association for Mathematical Geology, 6-12 September 2001, Cancun, Mexico. 17 pp, 2001

The Earth Resources Center of the University of California, Berkeley has developed a method for screening abandoned mine sites that integrates new digital technology. The method focuses on volcanogenic massive sulfide deposits and uses an integrated field method that combines digital sub-meter accuracy GPS and laser-based mapping with infrared and visible reflectance spectroscopy,

supported by periodic water sampling and AAS geochemistry. At old mine sites, pyrite oxidation in combination with surface runoff, evaporation, and capillary rise creates soluble secondary minerals that release contaminants into adjacent watersheds and aquifers upon dissolution. The integrated mapping system surveys the mine sites and maps their surface mineralogy in a minimal amount of time. This method is particularly useful for areas difficult to access due to distance, time, or property access permissions, because survey parameters such as grid size and sampling density can be adapted according to the initial results obtained and viewed in the field in real time. Site-specific or temporally varying features can be mapped with GeoMapper software in detail, e.g., zonation of secondary minerals, country rock geology and its potential for acid neutralization, intermittent and small stream drainages, old mine structures, rock/soil and water sampling sites, boundaries of disturbed vs. undisturbed waste rock, types of mineral processing waste. Environmental mapping combined with periodic water sampling and analysis provides a tool for relating the mineralogical dynamics of mine dumps to river chemistry. By identifying and mapping products of sulfide oxidation that are indicative of acidification (such as copiapite and jarosite) via ground and helicopter surveys, it becomes possible to screen the most problematic sites for further characterization and selective remediation.
http://www.kgs.ukans.edu/Conferences/IAMG/Sessions/G/takagi.html

Intelligent Systems for Environmental Monitoring
Wadsworth, Derek (INEEL, Idaho Falls, ID); Ronald Lujan.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 138, 2002

Integrating research and development capabilities with environmental monitoring activities required at INEEL has resulted in the deployment of the Remote Air Monitoring System (RAMS) and the Robotics Insitu Gamma System (RIGS). These two systems provide unmanned monitoring and characterization of large expanses of air and large land areas. RAMS is a remotely operated or autonomous aerial platform that deploys portable air sampling equipment and aerial video surveillance systems. The systems collect data previously considered too costly or unobtainable. RIGS is a remote and/or robotically operated radiological characterization system with the capability of performing parallel swath surveys of an area. INEEL encompasses several thousand acres, and environmental regulations require a periodic survey of the site. These surveys monitor gamma radiation levels that may be above background levels. Previous monitoring techniques required two individuals to drive a sensor-equipped vehicle over the area of interest. RIGS removes the operators from potentially hazardous environments and provides more accurate and complete results at reduced costs. The RAMS and RIGS technologies are not limited to their current use. By simply changing sensors the systems can be used for ordinance detection, airborne contamination detection and mapping, and any other application where large areas (air or ground) need to be monitored.

Laboratory and Airborne Reflectance Spectroscopic Analyses of Lignite Overburden Dumps
Krueger, G.; J. Erzinger; H. Kaufmann.
Journal of Geochemical Exploration, Vol 64 No 1-3, p 47-65, 1998

Visible and infrared reflectance spectrometry was used for a mineralogical/chemical analysis of open pit lignite mine overburden dumps. Spatial compositional information of the dumps is important for the study of geochemical alteration and its hydrogeological effects, as well as for the definition of the most suitable remediation goals and means. The Central German Lignite Mining District includes two open pits: Zwenkau (active) and Espenhain (abandoned). This paper presents quantitative determinations of organic carbon, kaolinite, and pyrite contents based on their distinct diffuse spectral reflectance properties. The spectrometric means applied include laboratory and field spectrometry, as well as imaging spectrometry based on airborne hyperspectral data of the Digital Airborne Imaging

Spectrometer (DAIS 7915). Spectral analyses have been applied to the dumps in the field, field samples in the laboratory, and mixture series of field samples and mineral standards. Chemical and mineralogical analyses of the field samples served as references and were successfully correlated to absorption features of laboratory reflectance spectra. Based on the relative absorption depth, kaolinite contents were derived with an accuracy of about 2 wt. % for the low contents present in the dumps (<10 wt. %). Organic carbon was quantified over the full natural range from 0 to 60 wt. %, with an accuracy of about 2 wt. %. Comparable accuracy applies to the quantitative estimation of pyrite contents. The Espenhain mine was quantitatively mapped for kaolinite contents, using atmospherically corrected hyperspectral DAIS 7915 data. The result is a map of kaolinite concentrations from <1 to >10 wt. %, classified into six groups, with a ground resolution of approximately 10 m.

Landfill Monitoring and Leak Location

Taylor, Steven; Ron Barker, Univ. of Birmingham, UK. Website, 2003

Electrical monitoring for leaks in the landfill liner and observation of temporal changes in the electrical properties of the underlying sandstone have been carried out over a period of eight years at the Cleanaway-operated landfill at Sandy Lane, near Bromsgrove. The monitoring system consists of more than 400 electrodes arranged in a grid beneath the high density polyethylene geomembrane liner of the landfill. Research carried out on data collected at the site has led to the development of parameter optimization software to improve on the accuracy with which leaks can be located using the under-liner system. This typically can improve the location accuracy from 20 m to less than 5 m. Leaks are then located precisely for repair wuth a surface geomembrane leak location survey (GLLS), which uses the same principles as the under-liner method but is conducted on a finer grid above the liner. A comparative study at the site between the under-liner monitoring system and the more conventional GLLS has been conducted, indicating that the former can out-perform the latter in certain circumstances and under certain site conditions. A major part of the work has been the characterization of the electrical properties of the sandstone (the Triassic Wildmoor Formation) on which the landfill has been constructed. This has involved detailed studies on sandstone cores taken from the site, including measurements of the variation of resistivity with pore water saturation level and pore water salinity. The aim of the work was to enable a more comprehensive understanding of the unsaturated zone directly beneath the landfill and to help explain the observed temporal variations in the electrical response of the sandstone at the site.
http://www.earthsciences.bham.ac.uk/downloads/taylor1.pdf

A Laser Based Drilling System for Characterization, Monitoring, and Remediation Wells

Parker, R. (Subsurface Laser Applications, Inc., Arvada, CO); M.C. Edelson; L.G. Everett; R. Miller. Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 39, 2002

A research team at Subsurface Laser Applications, Inc., has been formed to create a laser-based drilling system for environmental characterization, monitoring, and remediation boreholes. “Laser-based” means that the hole is created primarily by the use of laser energy. Laboratory tests show conclusively that, even without optimizing the system, energy requirements are similar or lower than mechanical systems. The research team performed tests on soft and hard material in February 2001. The tests showed that loose soil-like material could be penetrated by the laser beam, with the added benefit of welding grains together at the hole wall to form a stable wellbore. The results of these tests led to the following conclusions: (1) commercially available lasers can create holes in near-surface soils suitable for characterization, monitoring, and remediation; (2) sand (and mixed sand and gravel) can be penetrated by laser energy and the grains welded into a casing to maintain the borehole integrity after the drilling apparatus is removed; (3) pebble-sized gravels can be penetrated without disturbing the individual rocks; and (4) further work needs to be done to determine if the welded pebbles form a competent sheath.

Localization and Speciation of Zn in Mycorrhized Roots by µSXRF and µEXAFS
Sarret, G.; W.H. Schroeder; M.A. Marcus; N. Geoffroy; A. Manceau, LGIT Univ. de Grenoble, CNRS, Grenoble, France.
XII International Conference on Heavy Metals in the Environment, 26-30 May 2003, Grenoble, France
Journal De Physique IV, Vol 107 No II, p 1193-1196, May 2003

Mycorrhized roots of tomato plants grown in a Zn-contaminated soil were investigated at the micron scale using micro-synchrotron-based X-ray fluorescence (µSXRF) and micro X-ray absorption spectroscopy to determine the distribution of metals and the speciation of Zn. Zn associated to the root as Zn malate and/or Zn citrate, and Zn associated to the fungus as Zn phyllosilicate. This study illustrates the great potential of X-ray microbeams for the study of biological samples containing various amounts of metals, such as harvested plants used for phytoextraction.

Long-Term Monitoring for Explosives-Contaminated Groundwater
Fisher, Mark, Nomadics, Inc., Stillwater, OK.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Technical Abstracts, p 46, 2002

Cost-effective technologies are needed for long-term, in situ monitoring of ground water for contamination by explosives. Nomadics originally developed a sensor system for detection of nitroaromatic explosives as part of the DARPA-funded Dog's Nose Program. Under field conditions, this system was able to detect ultra-trace concentrations of vapor-phase nitroaromatic compounds emanating from the explosive charge contained in landmines. The technology is based on amplified fluorescence quenching of novel polymer materials that occurs when molecules of nitroaromatic explosives bind to films of the polymer. The polymers, developed by collaborators at the Massachusetts Institute of Technology, have enabled development of sensors capable of detecting one femtogram (1 x 10^{-15} grams) of TNT vapor. The technology has recently been adapted for underwater detection of TNT emanating from unexploded ordnance. During recent field tests, the sensor was able to detect TNT in water downcurrent of TNT sources in the water column. As part of a SERDP-funded SEED project, this sensor is now being adapted to fit into a downhole water monitoring probe to facilitate detection of TNT and certain TNT degradation products in ground water. A prototype sensor has been constructed, and preliminary laboratory testing of the prototype has yielded promising results.
The sensor currently can detect TNT in water at a concentration of 3 x 10^{-9} molar (approximately 700 ppt by mass). The sensor response to TNT is rapid (on the order of a few seconds), and is reversible, enabling numerous detection cycles using the same polymer film. The system does not utilize any consumable chemical reagents during operation, providing the possibility for unattended, long-term, cost-effective monitoring for TNT in ground water. Preliminary test results are presented, along with possible system implementations.

Low-Cost OP-FTIR for Air Quality Monitoring
Rentz, Julia H. (OPTRA, Inc., Topsfield, MA); J.R. Engel; D.L. Carlson; D.J. Mansur; R.M. Vallaincourt; P.R. Griffiths; H. Yang.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 146, 2002

OPTRA has developed a low-cost, compact, rugged open-path Fourier transform infrared (OP-FTIR) spectrometer system for workplace air quality monitoring. The research was funded under a U.S. Air Force SBIR Phase II contract. The goal of the program has been to identify and eliminate aspects of high cost and complex user requirements common to currently available OP-FTIR systems. This low-resolution system employs an uncooled DLATGS detector and a novel encoder-based reference metrology to control the scanning mirror and clock the interferogram. Other design economies include a plastic injection-molded retroreflector array to return the open-path beam. This effort has included the development of a set of algorithms based on artificial neural networks and partial least squares by the University of Idaho; these algorithms are specifically tailored to low-resolution systems applied to multi-component analysis of large, organic molecules characterized by broad infrared resonance bands. The algorithms, coupled with the OP-FTIR, are designed to identify and quantify a list of 19 common industrial organic molecules in the presence of varying humidity levels. The OP-FTIR is capable of autonomous stand-alone operation, logging concentration levels of the target compounds over time and alarming in the presence of concentrations approaching OSHA's respective Permissible Exposure Limits. The system includes two PCI boards that host all OP-FTIR processing and servo electronics; the boards reside in a PC along with a user-friendly Graphical User Interface in a small suitcase.

Luminescent Sensors for the Detection of Chemical Agents in Water
Jenkins, Amanda Leigh (U.S. Army Research Lab., Aberdeen Proving Ground, MD); Ray Yin, Dujie Qin, Janet Jensen, H. Dupont Durst.
PITTCON 2001, Abstracts, p 1361, 2001

The organophosphorus nerve gases Sarin and Soman are the agents used on troops in the Iran/Iraq War, and they currently are leaking from stockpiles of aging weapons in the United States. Many pesticides and insecticides are so chemically similar to nerve agents that they trigger the same decrease in the enzyme plasma cholinesterase as the agents themselves. Growing concerns over possible contamination of water supplies by nerve agents, insecticides, and pesticides has prompted the desire for small portable devices that can quickly detect trace amounts of these substances in water. Novel polymeric materials based on molecular imprinting techniques have been constructed for detection of phosphonate-containing species in water. Detection is based on sensitized luminescence that occurs when the analyte selectively binds a luminescent europium reporter molecule incorporated in the polymer. This interaction is so specific it can discriminate two almost identical species such as chloropyrifos methyl and chloropyrifos ethyl. A miniature fiber-optic spectrometer monitors the changes in luminescence that result when the analyte is reversibly bound to the co-polymer. Several of these fibers, each for a specific analyte, are mulitplexed together. The limit of detection for these sensors are in the low parts per trillion in solution with linear ranges from low ppt to ppm. The sensors exhibit the same recognition characteristics over several months of use with a response time of less than 5 minutes. Selectivity of the sensors against other pesticides and chemically similar compounds has been demonstrated.

Mapping a Failing Septic Field with Electromagnetic Induction
Taylor, Rick (Dualem); Brad Lee (Purdue Univ.); Jim Doolittle (USDA-NRCS).
FastTIMES: the 2003 SAGEEP Issue, Vol 8 No 1, p 9- , Mar 2003

In 2001, the Ft. Wayne-Allen County Health Department identified several failing septic systems in the suburbs of Ft. Wayne, IN, through field observation and water-quality monitoring of nearby streams. One such system had been installed in a fine-textured (35 to 50% clay) soil of low permeability to service a home on a 2-acre lot. The system failed due to hydraulic overloading, caused by excessive water use in the home and heavy precipitation, which resulted in ponded wastewater on the lawn. The field was saturated when it was surveyed in December 2001.The geophysical instruments used to map

the field included a DUALEM-2.The DUALEM-2 is an EMI instrument designed to measure ground conductivity at low induction number (LIN). The instrument contains coils that operate in both the horizontal co-planar (HCP) and perpendicular (PRP) geometries. Transmitter-receiver separation is about 2 m. At LIN, the PRP geometry is sensitive to conductivity fluctuations to a depth of about 1.2 m beneath the instrument, and the HCP geometry is sensitive to a depth of about 3 m.
http://www.eegs.org/fasttimes/files/FastTIMES_March2003.pdf

A Mathematical Modeling Approach to Improve the Point Estimation of Landfill Gas Surface Emissions Using the Flux Chamber Technique
Perera, M.D.N.; J.P.A. Hettiaratchi; G. Achari.
Journal of Environmental Engineering Science, Vol 1 No 6, p 451-463, 2002

The accurate determination of gas emissions from sanitary landfills is necessary to assess and control emissions from individual landfills. The most popular method available for point measurement of landfill gas, the closed or static flux chamber technique, has inaccuracies associated with the technique itself. The authors present a new mathematical modeling approach to estimate the errors caused by changes to the flow pattern of gases within the soil cover when a closed flux chamber is placed on top of the cover to measure gas emissions. The proposed two-dimensional numerical model considers both advective and dispersive processes of gas migration. The model was calibrated and verified using data from controlled laboratory experiments. The model was able to predict the fluxes with 95% accuracy. Based on laboratory experiments and model predictions, analysis showed that a closed flux chamber technique would underestimate actual gas flux by as much as 65%, depending on the configuration of the flux chamber, the actual flux rate, and the characteristics of the soil in the landfill cover.

Membrane Introduction Mass Spectrometry (MIMS) for On-Site Analysis
Cooks, R.G. (Purdue Univ., West Lafayette, IN); L. Riter; Z. Takats; K. Koch; G. Patterson; Z. Ouyang.

PITTCON 2001, Abstracts, p 203, 2001

Membrane introduction mass spectrometry (MIMS) is a method by which volatile and semi-volatile compounds in aqueous and air samples can be identified and quantified down to low levels. The analytes partition into the membrane, typically a silicone polymer, and diffuse through it before being released into a (tandem) mass spectrometer. MIMS requires little or no sample preparation and is well-suited to on-line analysis, but it has seen limited application in this area because of the size, complexity, and relatively low reliability of mass spectrometers. This paper describes new membrane introduction systems that further improve detection limits of MIMS experiments, as well as a miniature ion trap mass spectrometer that is much more appropriately scaled to MIMS use than current commercial instruments. The authors describe initial applications of the MIMS/miniature cylindrical ion trap combination focused on the detection of chloramines in water and nitroaromatics and dimethyl methylphosphonate in air. Two innovations in the membrane introduction system are introduced. In single-sided MIMS, less volatile compounds are examined by a trap-and-release process in which they are partitioned into but not required to diffuse through the membrane; instead they are thermally released from the same side. The second method employs a membrane with much higher surface area than is commonly used, and it provides low parts per trillion detection limits for a variety of compounds in air samples.

Microdevice Based on Integration of Capillary Electrophoresis Microchips with Electrochemical Detector for Monitoring of Explosives
Lin, Yuehe (Pacific Northwest National Lab., Richland, WA); Joseph Wang.

Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 40, 2002

A portable capillary electrophoresis (CE) microdevice, based on the combination of microfabricated separation chips and thick-film electrochemical detector strips, was developed to provide reliable, cost-effective characterization of ground-water contamination. The microdevice consists of a planar screen-printed carbon line electrode mounted perpendicular to the now direction. Such coupling obviates the need for permanent attachment of the detector, to allow easy and fast replacement of the working electrode. Variables influencing the separation efficiency and amperometric response, including the channel-electrode spacing, separation voltage, or detection potential, are assessed and optimized. The versatility, simplicity, and low-cost advantages of the design are coupled to an attractive performance, with submicromolar detection limits and good precision. Applicability for assays of mixtures of nitroaromatic explosives has been demonstrated. On-line coupling of preconcentration/microchip separation for explosives also is presented.

A Miniature Fiber-Optic Resonance-Enhanced Multiphoton Ionization (REMPI) Probe with No Focusing Optics
Chinni, R. and B.W. Colston (Univ. of South Carolina, Columbia); D.M. Gold, S.B. Brown, and D. LeSage (LLNL, Livermore, CA).
PITTCON 2001, Abstracts, p 734, 2001

The authors have developed a miniature fiber-optic resonance-enhanced multiphoton ionization (REMPI) probe with no focusing optics for in situ analysis of VOCs. REMPI can provide quantitative and qualitative information about vapor-phase VOCs by detecting specific contaminants and distinguishing them from other species in the sample. The new REMPI probe design uses an optical fiber to transmit a laser pulse to the sample, causing it to ionize through a resonant multiphoton process. The optical fiber is contained within a 2-mm inner diameter stainless steel syringe that serves as the electrode. The electrode is biased at a high positive potential and is used to collect the electrons that are produced by ionization of the sample, causing current to flow in an external circuit. The current is directly proportional to the concentration of the species ionized. Typical fiber-optic REMPI measurements require short analysis time, no sample preparation, and are sensitive at parts per billion. This paper discusses the measurement of REMPI excitation profiles in the UV (1+1) and visible (2+2) to determine the optimal wavelength for BTEX compounds, both alone and in mixtures. The long-term project goal is to develop a system for measuring and identifying a wide range of volatile organic hydrocarbons in situ in the subsurface using a fiber-optic REMPI probe in a cone penetrometer.

Miniature Multi-Analyte Sensing System for Water Quality Monitoring
Kidwell, David A. (Naval Research Lab. (NRL), Washington, DC); X. Wu; B.J. Van Wie; J.M. Mullin; M.A. Plesha.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 114, 2002

The Environmental Monitoring System (EMS) is a miniature (2” x 4”), inexpensive (<$150) electronic package that contains orthogonal sensors. It is capable of monitoring fluorescence, absorbance, conductivity, temperature, and chemical concentrations. The sensors are monitored continuously, once per second for up to 30 days. Data can be stored onboard the EMS or sent remotely through a RS232 or IR link. The device also is field-programmable to allow for greater flexibility. A future version will have enzymatic sensors, a pressure sensor, a radio link, and a releasable tethering system. The ion selective electrode arrays contain up to seven sensors, plus a reference in a 12 mm rod, and are field replaceable. The reference electrode is of an NRL design, and like the ion selective electrodes, easily fabricated. The authors have been developing miniaturized coated wire, liquid-filled, and solid-state ion selective electrodes for a number of ionic species. Results for monitoring of pH, chloride, phosphate, and potassium are presented. Because of copper's environmental importance, researchers also have been developing ion-selective electrodes for copper (I) and (II). Initial tests show limits of detection of 10^{-6} M, measurable within 10 to 20 seconds, and with minimal interferences from other species. Results are presented from assessments of system sensitivity and repeatability, membrane composition and methods of membrane manufacture, and the impact of buffer composition. Due to the low cost and small size of the EMS, it is expected that the system will find broad utility for rapid on-site water quality monitoring. This work was partially funded by SERDP.

Monitoring and Classification of PAH Toxicity Using an Immobilized Bioluminescent Bacteria
Lee, Hyun Joo; Julien Villaume; David C. Cullen; Byoung Chan Kim; Man Bock Gu.
Biosensors and Bioelectronics, Vol 18 Nos 5-6, p 571-577, May 2003 [Selected papers from the Seventh World Congress on Biosensors Kyoto, Japan 15-17 May 2002]

An immobilized recombinant bioluminescent *Escherichia coli* strain harboring a lac::lux CDABE-fused plasmid was used to monitor the cellular toxicity of polycyclic aromatic hydrocarbons (PAHs). The biosensor response differentiated between PAHs classified as pericondensed (PCPAHs) or catacondensed (CCPAHs) according to their molecular structures. Only CCPAHs were found to cause cellular toxicity, resulting in a dose-dependent decrease in the bioluminescent output. The induction of cellular toxicity by CCPAHs and PCPAHs was compared with acute toxicity predictions obtained using the quantitative structure-activity relationship (QSAR) model. A good relationship was obtained between the toxicities determined with the bioluminescent response of the immobilized bacterium GC2 and the QSAR model. The work offers a new method of predicting the cellular toxicities of CCPAHs or PCPAHs using this biosensor.

Monitoring Freshwater Sediments
Alcock, S.; D. Barcelo; P.-D. Hansen.
Biosensors and Bioelectronics, Vol 18 No 8, p 1077-1083, 1 Aug 2003

The SENSPOL Expert Meeting on `Monitoring Freshwater Sediments' held in Antwerp, Belgium, 12-13 September, 2001, identified and defined problems and began the development a realistic strategy to solve these problems. Representatives of government authorities and the dredging industry present at the workshop participated in detailed discussions to elucidate the role of sensors in the field of sediments and sediment/water interfaces. The 19 invited experts were agreed that in situ monitoring systems are needed to monitor freshwater sediments. The main focus for development of new sensor tools should be for on-site determination of priority pollutants that improve on existing methods or fill a gap where no suitable method exists, and to monitor biological effects (alarm systems and effect-related on-site tests). Sensing technologies would also be useful to monitor bioavailability in sediments in situ for risk assessment and to monitor bioremediation in situ. New sensing tools presented included the thin films (DGT) technique (Lancaster University, UK) for determination of metal concentrations in sediments using diffuse gradients; an analytical protocol for determination of metal speciation in sediments (Universitat Autonoma de Barcelona, Spain); microbiotests for determination of sediment toxicity (University of Ghent, Belgium); a portable whole-cell sensor device for heavy metal bioavailability (VITO, Belgium); and a microfabricated sensor array system for Pb concentration profile measurement in the M range at the liquid/solid interface (University of Geneva, Switzerland).

Monitoring Rhizosphere-Enhanced Treatment of Petroleum-Contaminated Soils, a Low Cost Remediation Strategy For Extensive or Remote DoD Sites

Reynolds, Charles M. (Cold Regions Research and Engineering Lab., Hanover, NH); D.B. Ringelberg; K.L Foley; L.B. Perry; BA. Koenen; K.J. McCarthy.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 56, 2002

Though rhizosphere-enhanced remediation is an attractive passive treatment alternative, it is difficult to determine the extent, progress, and endpoints of the process. With support from SERDP, ESTCP, Army EQT, and PACAF, the authors conducted field demonstrations at six locations in wide-ranging climates. Each field demonstration was a factorial experiment, with vegetation and fertilizer as the main factors. Each treatment was replicated four times using a randomized complete block design. For vegetation, they used either annual ryegrass or a mixture of grasses and clover. Locally available agricultural fertilizer was used at each site. Both GC-FID and GC-MS techniques were used to obtain both "raw" and biomarker-normalized depletions of total petroleum hydrocarbons (TPH), fraction-specific hydrocarbons (FSH), and individual petroleum compounds, primarily polynuclear aromatic hydrocarbons (PAH). Using either raw TPH or biomarker-normalized TPH as a monitoring variable, they observed a fertilizer main effect in some cases, yet TPH based monitoring generally did not show a vegetation effect. However, with biomarker-normalized PAHs they observed either positive vegetation or a fertilizer-vegetation interactions. TPH-based monitoring generally was not sufficiently precise to observe treatment interactions. These data demonstrate the importance of selecting monitoring techniques that are tailored to measure the processes that are occurring rather than using less specific monitoring parameters such as TPH. For short-term monitoring of attractive yet relatively slow strategies, such as rhizosphere-enhanced remediation, appropriate selection of monitoring criteria are critical.

Monitoring the Process of Phytoextraction of Zinc and Cadmium by Indian Mustard Using Reflectance Spectrometry
Sridhar, B.B.M.; Y. Su; D.L. Monts, Diagnostic Instrumentation & Analysis Lab. (DIAL), Mississippi State Univ., Starkville.
The 18th Annual International Conference on Contaminated Soils, Sediments and Water, 21-24 October 2002, University of Massachusetts at Amherst.
Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. CD-ROM, 2002

A project to monitor surface and subsurface metal contamination by remote sensing of plant physiological status focuses on the spectral signatures that indicate the impact and content of heavy metals in the leaves and canopies of living plants. Potted plants of Indian Mustard (*Brassica juncea*) were grown for five weeks before being exposed to Zn and Cd at medium- and high-level concentrations and combined medium Zn and Cd concentration. The reflectance spectra (from 350nm to 2500nm) of the plant canopy were collected daily via a portable spectroradiometer with both solar irradiation in the field and artificial illumination inside a laboratory. Chemical analysis of harvested plant shoots showed significant amount of metal accumulation. Spectral analysis revealed that the reflectance spectra in the near IR region (from 780nm to 1350nm) correlated closely to metal accumulation in plant shoots. Further in-depth spectral analysis shows that the band ratio of the spectral reflectance at 1110 nm and 810 nm might be used as an indicator for metal accumulation in plant shoots. This study suggests that NIR reflectance spectra might be used as a reliable, non-intrusive, non-contact monitor for phytoextraction of metals.

National Overview of Abandoned Mine Land Sites Utilizing the Minerals Availability System (MAS) and Geographic Information System (GIS) Technology
Ferderer, David A., USGS.
U.S. Geological Survey Open-File Report 96-549, 1996

The approach utilized in this study combines the power of Environmental Systems Research Institute (ESRI) GIS software, existing minerals databases, and an intuitive method of screening minerals data to locate areas or regions where significant mineral-related and mining activities have occurred. The technology combines this information with other digital layers to help prioritize sites on a national basis. “Significant” is a relative term, and is defined here as mines or sites that contain hardrock commodities as the primary commodity, and sites with evidence of past mining production. Intuitively, these locations, because of human activity and workings, are more likely to contain exposed physical and chemical hazards. Ultimately, they have elevated potential to affect the public health and environment. Special emphasis will be placed on these sites as they relate to Interior lands, watersheds, and populated regions.
http://geology.cr.usgs.gov/pub/open-file-reports/ofr-96-0549/ofr-96-549.html

Near Real-Time Biosensor-Based Detection of 2,4-Dinitrophenol
Carter, Robert M.; Robert C. Blake II; Trong D. Nguyen; Levon A. Bostanian.
Biosensors and Bioelectronics, Vol 18 No 1, p 69-72, Jan 2003

A fluorescent biosensor assay has been developed for near real-time detection of 2,4-dinitrophenol (DNP). The assay is based on fluorescent detection principles that allow for the analysis of antibody/antigen interactions in solution using the KinExA™ immunoassay instrument. KinExA™ consists of a capillary flow observation cell containing a microporous screen that maintains a compact capture antigen-coated bead bed. The bead bed is comprised of polymethylmethacrylate (PMMA) beads coated with dinitrophenol-human serum albumin (DNP-HSA) conjugate. Phosphate-buffered saline (PBS) solutions, containing various concentrations of free DNP, are incubated for 30 min with mouse anti-DNP monoclonal antibody to equilibrium. Solutions containing the DNP-monoclonal antibody complex and possible excess free antibodies are passed over DNP-HSA labeled beads. The free monoclonal anti-DNP antibody, if available, is bound to the DNP-HSA fixed on the beads. The system is flushed with excess PBS to remove unbound reactants in the bead bed. The beads are subjected to brief contact with PBS solutions containing goat anti-mouse fluorescein isothiocyanate (FITC)-labeled secondary antibody, once again, followed by a short PBS flush. The fluorescence is recorded during the addition of the FITC labeled secondary antibody to the bead bed through the final PBS flushing with the KinExA™. The amount of DNP detected is then determined from the fluorescent slopes generated or by the remaining fluorescence retained on the beads after final PBS flushing of the system. The assay has been able to detect a minimum of 5 ng/ml of DNP in solution and can be adapted for other analytes of interest simply by changing the capture antigen and antibody pairs.

New Highly Sensitive and Selective Catalytic DNA Biosensors for Metal Ions
Lu, Yi; Juewen Liu; Jing Li; Peter J. Bruesehoff; Caroline M.-B. Pavot; Andrea K. Brown.
Biosensors and Bioelectronics, Vol 18 Nos 5-6, p 529-540, May 2003 [Selected papers from the Seventh World Congress on Biosensors Kyoto, Japan 15-17 May 2002]

The authors have used in vitro selection to obtain catalytic DNA that can bind a metal ion of choice strongly and specifically. The metal ion selectivity of the catalytic DNA was further improved using a `negative selection' strategy where catalytic DNA strands selective for competing metal ions are discarded in the in vitro selection processes. By labeling the resulting catalytic DNA with a fluorophore/quencher pair, metal ion fluorescent sensors have been created that are the first examples of catalytic DNA biosensors for metal ions. The sensors combine the high selectivity of catalytic DNA with the high sensitivity of fluorescent detection, and can be applied to the quantitative detection of metal ions over a wide concentration range and with high selectivity. The use of DNA sensors in detection and quantification of lead ions in environmental samples (i.e., water from Lake Michigan) has been demonstrated. DNA is stable, cost-effective, environmentally benign, and easily adaptable to optical fiber and microarray technology for device manufacture. The DNA sensors described here hold great promise for on-site and real-time monitoring of metal ions in environmental, medical, and industrial processes.

Non-Invasive Determination of the Location and Distribution of Free-Phase Dense Nonaqueous Phase Liquids (DNAPL) by Seismic Reflection Techniques. Annual Technical Progress Report (October 1, 2000 - October 1, 2001)
Waddell, Michael G.; William J. Domoracki; Tom J. Temples, Univ. of South Carolina, Columbia.
NTIS: DE00791064, 66 pp, Dec 2001

This annual technical progress report describes the status of Task 4, 5, and 6 (site evaluation, 2D seismic design and acquisition, and interpretation) at two deployments. The first deployment tested the feasibility of using non-invasive seismic reflection and AVO analysis as a monitoring tool to assist in determining the effectiveness of Dynamic Underground Stripping (DUS) in removal of DNAPL. The second deployment was at Charleston Naval Weapons Station Solid Waste Management Unit 12 (SWMU-12), Charleston, SC, to further test the technique to detect high concentrations of DNAPL. Based upon the water samples and MIP probes, it appears that surface seismic and AVO analysis were able to detect the area of highest concentration of DNAPL.
http://www.osti.gov/dublincore/gpo/servlets/purl/791064-yleBUm/native/

Novel Application of Digitally Integrated Mapping Systems for the Mineralogical Characterization of Abandoned Mines
Montero Sanchez, I.C.; G.H. Brimhall.
Annual Meeting of the Geological Society of America. Abstracts with Programs, Vol 30 No 7, p A-358, 1998

Abstract not available.

Novel Synthetic Phytochelatin-Based Capacitive Biosensor for Heavy Metal Ion Detection
Bontidean, I.; J. Ahlqvist; A. Mulchandani; W. Chen; W. Bae; R.K. Mehra; A. Mortari; E. Csoregi.
Biosensors and Bioelectronics, Vol 18 Nos 5-6, p 547-553, May 2003 [Selected papers from the Seventh World Congress on Biosensors Kyoto, Japan 15-17 May 2002]

This paper describes a novel capacitance biosensor based on synthetic phytochelatins for sensitive detection of heavy metals. Synthetic phytochelatin (Glu-Cys)20Gly (EC20) fused to the maltose binding domain protein was expressed in *Escherichia coli* and purified for construction of the biosensor. The new biosensor was able to detect Hg, Cd, Pb, Cu, and Zn ions in the order of SZn>SCu>SHg>>SCdSPb. The biological sensing element of the sensor could be regenerated using EDTA and the storage stability of the biosensor was 15 days.

Novel Voltammetric Probe for Real-Time Trace Element Concentration Profile Measurements at Sediment-Water Interface
Tercier-Waeber, M.L. (Univ. of Geneva, Geneva, Switzerland); J. Pei; J. Buffle; G.C. Fiaccabrino; M. Koudelka-Hep; G. Riccardi; F. Confalonieri; A. Sina; F. Graziottin.
PITTCON 2001, Abstracts, p 905, 2001

Changes in interstitial water chemistry with sediment depth are sensitive indicators of ongoing diagenetic reactions (i.e. chemical, physical, and mineralogical reactions occurring in sediments during and after their deposition). The exchange of trace elements between the sediment and the overlying water also is an important aspect in the geochemical cycling of the trace elements. Such measurements are not straightforward: the top layer of sediment, which significantly influences the fluxes of the trace elements, is characterized by a chemical multilayer microstructure with individual thickness of a few hundred to a few thousand micrometers. This layer is perturbed by sampling and storage. The authors present a novel analytical system called Sediment-water Interface Voltammetric In situ Profiling (SIVIP) System that was developed to meet this challenge. It allows real-time, high spatial resolution concentration profile measurements of trace elements (i.e., Cu(II), Pb(II), Cd(II), Zn(II), Mn(II), Fe(II)). The heart of the system is a novel gel-integrated microsensor array with 64 individually addressable lines. Measurements are performed simultaneously over the 64 lines using a powerful multiplexing system and a single potentiostat.

Nuclear Probe May Be New Weapon Against Acid Mine Drainage, Salinity
Land Contamination & Reclamation, Vol 10 No 4, p 291-292, 2002

A nuclear probe developed by CSIRO for minerals exploration and mining may soon be used to combat environmental problems. The probe could help prevent acid rain. Acid rain is caused when high sulfur fossil fuels are burnt, and some coal found in Europe and North America is high in sulfur. Armed with data from the probe, companies will be able to leave high-sulphur coals in the ground. Scientists expect that the portable borehole logging instrument, one of CSIRO's SIROLOG suite of products, will be used to measure sulfur in mine waste rock and in coal. High sulfur concentrations in waste rock cause acid mine drainage. The sulphur oxidizes and combines with water to form sulphuric acid, which, in high volumes, has an adverse effect on the environment. The probe centers on 'neutron capture' in a technique called prompt gamma neutron activation analysis (PGNAA). Neutrons emitted by a source, the artificial isotope californium-252, hit the rock and are captured by the nuclei of atoms in it. The nuclei are now slightly heavier and in an excited state. They relax by ejecting gamma rays, the energy of which betrays the identity of the elements. The probe complements chemical analysis, and since it investigates bulk properties, it generates data that are more representative than chemical data. The PGNAA probe is part of the SIROLOG suite of instruments in use in Australia and overseas for exploration, mine planning, and production. Initially designed for the mining industry, the probe is also being evaluated for its potential as an environmental management tool. It is one of several products including hand-held instruments and other borehole logging probes based on natural gamma and gamma-gamma techniques. CSIRO also hopes to use the probe to measure salt concentrations in soil as part of its assault on dryland salinity.

Old Mining Site Characterization by Sequential Chemical Extraction: a Case Study in Portugal
Patinha, C.; E.F. Silva; E.C. Fonseca.
Proceedings of the Fifth International Symposium and Exhibition on Environmental Contamination in Central And Eastern Europe, Czech Republic, p 156, 2000

Abstract not available.

On-Site Analysis of Contaminated Surface Water
Levsen, Karsten, Fraunhofer Inst. of Toxicology and Aerosol Research, Hannover, Germany.
PITTCON 2001, Abstracts, p 200, 2001

Individual organic compounds in polluted water are monitored primarily with chromatographic methods. Automation for on-site monitoring is achieved most easily if solid phase extraction (SPE), solid phase microextraction (SPME), or membrane extraction (such as MESI) is used for sample enrichment. Solid phase and membrane extraction can be readily coupled to a chromatographic unit. Depending on the polarity and volatility of the compounds, the on-line enrichment is combined either with gas chromatography (mass spectrometry), GC (MS), or high performance liquid chromatography (LC-MS). Volatile compounds in river water also can be analyzed by direct coupling of membrane extraction to mass spectrometry (MIMS). On-line SPE-GC(MS) and on-line SPE-LC(MS), as well as MIMS and SPME coupled to GC(MS) are particularly suitable for automated on-site monitoring of polluted river water. As a result of the large mass spectra libraries available, SPE-GC/MS and SPME-GC/MS and also MIMS, are suitable for non-target screening of polluted surface water, but equally well-suited for quantitative target analysis. Non-target screening of polar compounds is more difficult with SPE-LC/MS. This very powerful hyphenation is used mainly for target analysis, such as pesticides. The use of special sorbents in on-line SPE-GC/MS and in on-line SPE-LC/MS allows the specific enrichment of target compounds or compound classes. Such an increase in selectivity is achieved using immunoaffinity sorbents or molecular imprinted polymers, which can also be applied with SPME. For ionic compounds, ion exchange sorbents are available. The problem of humic acid interferences can be overcome using restricted access material (RAM), which allows the exclusion of high molecular weight compounds.

Optical Biosensor for Simultaneous Detection of Captan and Organophosphorus Compounds
Choi, Jeong-Woo; Young-Kee Kim; Byung-Keun Oh; Sun-Young Song; Won Hong Lee.
Biosensors and Bioelectronics, Vol 18 Nos 5-6, p 591-597, May 2003 [Selected papers from the Seventh World Congress on Biosensors Kyoto, Japan 15-17 May 2002]

An optical biosensor consisting of GST and acetylcholinesterase (AChE)-immobilized gel film was developed to detect captan and organophosphorus compounds simultaneously in contaminated water. The sensing scheme was based on the measurement of decrease of products formation (s-(2,4-dinitrobenzene) glutathione and -naphthol by GST and AChE, respectively) due to the inhibition by captan and organophosphorus compounds. The absorbance of s-(2,4-dinitrobenzene) glutathione and -naphthol was detected at 400 and 500 nm, respectively. AChE was inhibited by both captan and organophosphorus compounds, and GST was inhibited only by captan. The proposed biosensor successfully detected captan and organophosphorus compounds at concentrations from 0 to 2 ppm.

An Overview of Single and Multielement Mercury Determination
Grosser, Zoe A., PerkinElmer Instruments, Wilton, CT.
PITTCON 2001, Abstracts, p 1348, 2001

This presentation summarizes detection capabilities for mercury determination with different techniques, i.e., ICP-OES, ICP-MS, and batch, with flow injection and continuous flow injection at various preconcentrations. The author matches the available analytical capabilities against current regulations to aid in choosing the right technique.

PCB Partitioning and Availability in Land Biotreatment Systems
McNamara, Sean W., thesis (Ph.D.), Carnegie Mellon University.
University Microfilm, Inc., Ann Arbor, MI. UMI Pub No: AAT 3051013, ISBN: 0-493-65335-X, 184 pp, 2002

A multi-year investigation was conducted to delineate factors affecting the aqueous-phase availability and bioremediation potential of PCBs derived from oily industrial wastes in land biotreatment systems. The research focused on the development of sampling techniques and the assessment of field and lab measures applied to equilibrium partitioning models. A new sorbent-wick sampling device was developed to provide in situ measurements of trace quantities of PCBs in the pore water of unsaturated soils in the biotreatment beds. The hydraulic characteristics of the new samplers were evaluated through laboratory tests in unsaturated soil columns, and the chemical capture and quantification potential of these devices were tested in the field and in lab soil column leaching experiments. The results indicate that these sampling devices are suitable for quantifying the average pore-water concentrations of chlorinated hydrophobic chemicals down to parts-per-billion levels. Equilibrium partition models were used to determine factors affecting the aqueous-phase availability of PCBs in land treatment systems and indicated that residual oil and grease largely controls the partitioning process. Because oil and grease degrade more readily, equilibrium aqueous-phase concentrations of PCBs were predicted and observed to increase over the treatment period. In general, active land biotreatment effectively reduced di- and trichlorobiphenyls, but little reduction was seen in higher chlorinated congeners. Successive years of passive biotreatment showed little if any further reductions in PCBs.

Photochemical Formation of Gold Nanoparticles in Aqueous Triton X-100 and Its Application for Cyanide Determination
Pal, A.; M. Bandyopadhyay.
Indian Journal of Chemical Technology, Vol 7 No 2, p 75-8, 2000

Abstract not available.

Physical and Geochemical Characterization of Mine Rock Piles at the Questa Mine, New Mexico
Shaw, S. (Robertson GeoConsultants, Vancouver, BC, Canada), C. Wels, A. Robertson; G. Lorinczi (Molycorp Inc., Questa Division, Questa, NM).
Tailings and Mine Waste '02, proceedings of the Ninth International Conference on Tailings and Mine Waste, 27-30 January 2002, Fort Collins, Colorado, p 447-458, 2002

The Questa molybdenum mine is located in the Sangre de Cristo mountains in Taos County, northern New Mexico. Currently, the mining operations consist of underground block caving; however, between 1965 and 1983 lower grade molybdenum ore (0.185% MoS_2, 74 million tons) was recovered by open pit mining methods, with some 320 million tons of waste rock produced. A comprehensive physical and geochemical characterization of the mine rock piles has been carried out at the site over the last few years to evaluate the current conditions and predict the future conditions. This paper describes the results of a drilling program completed as part of a larger, site-wide characterization program. The drilling program was carried out in phases with the objective of characterizing the geochemical and physical properties of the mine rock at surface and at depth and the oxygen and temperature variations with depth in the piles. Testing included (i) geochemical testing of drill cuttings (moisture content, paste pH/EC, ABA, leach extraction and forward acid titration testing); (ii) physical testing of mine rock samples (grain size analysis, moisture retention, permeability), and (iii) in-situ monitoring of temperature and oxygen/carbon dioxide in 10 boreholes. The results of the characterization study indicate that the majority of the mine rock, where it has been tested, is potentially acid generating, but, after more than 20 years, the mine rock may not have reached a mature state of oxidation and acid mine drainage. The particle size and moisture content of the mine rock is quite variable and the in situ temperature and oxygen monitoring suggest that there is ongoing sulfide oxidation and advective airflow (chimney effect) within the rock piles. The results of rock pile characterization and monitoring have been used to calibrate an air transport and ARD production model of the mine rock piles.
http://www.robertsongeoconsultants.com/papers/shaw_pub.asp

POL Sensor Validation of SCAPS. ESTCP Cost and Performance Report
U.S. DoD, Environmental Security Technology Certification Program (ESTCP). 47 pp, Mar 1997

This report focuses on technology demonstration objectives in which a laser-induced fluoresence (LIF) sensor was evaluated as a field screening method by comparing, in particular, the downhole Nd:YAG SCAPS-LIF with the nitrogen-based SCAPS-LIF and to data produced by conventional sampling and analytical methods. Generally, the SCAPS-LIF technologies produce results that agree well with conventional methods for qualitatively detecting subsurface petroleum. While the nitrogen-based LIF sensor has been certified by the California DTSC, the Nd:YAG SCAPS-LIF experienced difficulties in the field and has not gained formal regulatory acceptance. Nonetheless, as a field screening tool, SCAPS-LIF can delineate the distribution and boundaries of the contaminant source. At sites where the technology is applicable, results of the SCAPS-LIF field screening can be used to optimize the location and reduce the number of soil sampling borings and ground-water monitoring wells necessary to characterize a site. Such decisions can reduce the overall number of samples that need to be submitted for costly and time-consuming off-site laboratory analyses, and the time and costs associated with multiple or iterative field investigations. A cost savings ranging from 30 to 50% is possible when compared with conventional screening methods.
http://estcp.hgl.com/documents/techdocs/199517.pdf

Polluted or Nonpolluted--A Fuzzy Approach Determining Soil Pollution
Komac, Marko; Robert Sajn, Geological Survey of Slovenia, Ljubljana, Slovenia.
IAMG2001: Annual Conference of the International Association for Mathematical Geology, 6-12 September 2001, Cancun, Mexico. 12 pp, 2001

Defining something as polluted can be a difficult task. To avoid the subjective approach as much as possible, fuzzy logic methods were used to determine the ratio of pollution in the urban area of Slovenia's capital, Ljubljana. Fuzzy logic is widely used in many fields of research. Since it deals with gradual transition between two states, it also can be used when dealing with classifying specific media as polluted or non-polluted. In the summer of 1999, 103 urban geochemical samples (soil) were collected in a 500x500 meters matrix, and sampled for 36 elements, including some of the most toxic ones. Combining GIS and a simple inductive DSS method, pollution maps of the urban area for eight heavy metals (Cd, Co, Cr, Cu, Hg, Ni, Pb, and Zn) were produced. First a pollution index (PI) for each sampling point was calculated, using legislated permissible levels of heavy metals in soil. Fuzzy logic disjunction was used to separate the PI into six classifications: non-polluted, partially polluted, marginally polluted, polluted, very polluted, and extremely polluted. Then maps of the heavy metal pollution in the sampled area were produced using the universal kriging method. The pollution tendency of the elements Cd, Co, Hg, Pb, and Zn shows relationships in their spatial distribution. Zn and Pb show spatial relation with traffic density; the distribution of Hg show relatively high, almost critical values throughout the city; and Co values are on the margin between polluted or not. The values of Cd show spatial relation with three locations: the old city, the heating plant, and an old buried landfill. Cr, Cu, and Ni showed no patterns of spatial distribution; these elements were distributed more or less randomly in the sampled area.
http://www.kgs.ukans.edu/Conferences/IAMG/Sessions/K/komac.html

Portable Surface-Enhanced Raman Spectroscopy Instrument for Explosives Monitoring
Haas, John W., Applied Research Associates, South Royalton, VT.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Technical Abstracts, p 47, 2002

This presentation describes a portable Raman spectroscopy instrument and methods for monitoring explosives such as TNT in environmental and process water samples. The methods make use of a metal surface enhancement effect to strengthen normally weak Raman signals as much as 105 times to achieve detection of contaminants at low levels. Researchers have deployed and demonstrated the technology at the Alabama Army Ammunition Plant (ALAAP) where the SERS method was compared against colorimetric field tests and laboratory HPLC techniques for ground-water monitoring. The comparative results from ALAAP are a second major focus of the presentation.

Potential for Detection of Microorganisms and Heavy Metals in Potable Water Using Electronic Nose Technology
Canhoto, Olinda F.; Naresh Magan.
Biosensors and Bioelectronics, Vol 18 Nos 5-6, p 751-754, May 2003 [Selected papers from the Seventh World Congress on Biosensors Kyoto, Japan 15-17 May 2002]

Studies have been carried out using an electronic nose to determine the potential for the detection of different microbial species, alone and in the presence of low concentrations of different heavy metals (As, Cd, Pb and Zn) in bottled, reverse-osmosis (RO), and tap water. Studies show that it is possible to discriminate control water samples from water contaminated with 0.5 ppm of a mixture of metals. The presence of heavy metals can modify the activity of microorganisms and thus the volatile production patterns. Bacterial species at 102 to 104 colony-forming units (CFUs) mL could be detected after 24 h of incubation. Work is in progress with electronic nose technology to identify the limits of detection for other microorganisms (e.g., fungi and cyanobacteria) and chlorinated phenols.

Precise Contaminant Distribution Delineation Using Membrane Interface Probe (MIP) Technology
Nadolishny, A.; D. Ochs; P. Fleischmann.
In Situ Aeration and Aerobic Remediation. Battelle Press, Columbus, OH. p 139-144, 2001

The Membrane Interface Probe (MIP) is a real-time subsurface logging tool that provides continuous readout of relative VOC concentrations and electrical conductivity of the soil. The use of a rapid site assessment tool such as the MIP allowed crucial information concerning the distribution jet fuel in the subsurface to be obtained two days immediately prior to the injection of oxygen release compound (ORC™) to remediate the contaminant at a former Air Force Base in Portsmouth, NH. The data obtained with the high-resolution MIP system provided a distribution model dramatically different from the previous one based on data collected from the sampling of monitoring wells. The analysis of the data resulted in changes to the injection work plan, particularly the total depth of borings and the injection interval. Without such a precise distribution model, significant amounts of the ORC™ would have been wasted. The MIP logging was performed in one mobilization with the injection crew utilizing the same Geoprobe equipment that was later used for the ORC™ injection. This afforded a significant cost reduction. The Membrane Interface Probe (MIP) has been developed by Geoprobe Systems, Salina, KS. ORC™ is a registered trademark of Regenesis, San Clemente, CA. The field work was performed by crew and equipment provided by ZEBRA Environmental Corporation of Lynbrook, NY.

Preliminary Results of a NASA-Funded Hyperspectral Remote Sensing Project on Natural and Anthropogenic Sources of Impacted Drainage
Peters, D. (Peters Geosciences, Golden, CO); P. Hauff; M. Sares; F. Henderson III; D. Bird; E. Prosh; W. Peppin.
2003 SME Annual Meeting and Exhibit, 24-26 February 2003, Cincinnati, Ohio.
Society for Mining, Metallurgy, and Exploration, Littleton, CO. CD-ROM, 2003

A NASA-funded project is under way to determine the ability of hyperspectral remote sensing to map mineralogy that affects water quality within a watershed and to identify the relative contributions of natural and anthropogenic sources to that drainage. Hyperspectral data allow identification of fine details of mineralogical variations throughout a watershed and so should improve environmental assessments and tracking of impacts of acidic and/or metalliferous drainages. The first part of the project involves the Lake Creek watershed in central Colorado, a large tributary to the upper Arkansas River. The remainder of the project involves the upper Arkansas River and comparison of Lake Creek to the river, where the river is affected by drainage from the Leadville Mining district. This presentation covers preliminary results of the project derived from the study of Lake Creek.

Protein-Assisted Redox Sensing at Biomimetic Electrode
Tian, Yongchi; Jia Chen, Sarnoff Corp., Princeton, NJ.
NTIS: ADA412000, 20 pp, Feb 2003

Sarnoff Corp. is developing a biomimetic protein-assisted redox sensing system based on the organized molecular pathways found in nature. This system makes use of a biomimetic membrane coated on a gold electrode as a bio-electronic interface. The membrane will enable the nondissipative conversion of a redox event occurring in an aqueous medium to an electrical signal. The nondissipative conversion is enabled by lipid chains functionalized with prosthetics groups organized to mimic concerted, vectorial electron transfer. Sarnoff has designed and synthesized electron transfer molecules and engineered them into an organized self-assembled membrane (SAM). Researchers have demonstrated the vectorial transfer of electrons from a biofluid (aqueous) solution to an electrode with the membrane and have functionalized the SAM with proteins to demonstrate the sensing of redox reaction in aqueous solution.
http://handle.dtic.mil/100.2/ADA412000

Quartz Crystal Microbalance (QCM) Affinity Biosensor for Genetically Modified Organisms (GMOs) Detection
Mannelli, Ilaria; Maria Minunni; Sara Tombelli; Marco Mascini.
Biosensors and Bioelectronics, Vol 18 Nos 2-3, p 129-140, Mar 2003

A DNA piezoelectric sensor has been developed for the detection of genetically modified organisms (GMOs). Researchers immobilized single stranded DNA (ssDNA) probes on the sensor surface of a quartz crystal microbalance (QCM) device and monitored the hybridization between the immobilized probe and the target complementary sequence in solution. The probe sequences were internal to the sequence of the 35S promoter (P) and Nos terminator (T), which are inserted sequences in the genome of GMOs regulating the transgene expression. Two different probe immobilization procedures were applied: a thiol-dextran procedure and a thiol-derivatized probe and blocking thiol procedure.

Radon as a Natural Partitioning Tracer for Locating and Quantifying DNAPL Saturation in the Subsurface
Semprini, Lewis (Oregon State Univ., Corvallis); Jack Istok; Brian M. Davis.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 30, 2002

This presentation describes a study to evaluate the use of naturally occurring radon as an in situ partitioning tracer to locate and quantify DNAPL saturation and to monitor changes in DNAPL saturation during remediation. In the saturated zone, radon emanating from aquifer solids occurs as a dissolved gas, and due to its non-polarity, partitions into DNAPL. Partitioning between the DNAPL and aqueous phases results in retarded radon transport during ground-water flow. The radon retardation factor can be determined using single-well ‘push-pull’ tracer tests, enabling the calculation of the DNAPL saturation. Radon can also be used as a ‘static’ partitioning tracer, whereby grab samples of radon from monitoring wells in contaminated and non-contaminated portions of an aquifer (or from the same well before and after contamination) are collected and compared to calculate the DNAPL saturation. Both methodologies are being employed in a DNAPL-contaminated aquifer at the Dover National Test Site (DNTS), Dover Air Force Base, DE, under ESTCP Project No. CU-9916. The study site at DNTS consists of an aquifer test cell 27' long x 18' wide x 40' below grade. The test cell is equipped with 4 monitoring wells for conducting push-pull and static radon tests. Push-pull tests were performed before and after contamination of the test cell with PCE. The 'before' tests showed no evidence of radon retardation, while 'after' tests performed in well 3 showed evidence of retardation and suggested the presence of DNAPL near that well. Static radon samples were collected from the wells before and after contamination, and continue to be collected from 3'-long intervals in wells 2 and 3 using multilevel sampling lines. Long-term monitoring of radon concentrations in these wells is being conducted to investigate the effects of (1) bioremediation and (2) DNAPL migration on radon concentrations. Radon concentrations have increased at some depths between March and August 2002, suggesting that DNAPL may be migrating within the test cell.

Rapid Analysis of ppb Levels of Metals in Water
Driscoll, John N. (Process Analyzers, LLC, Walpole, MA); Timothy Bishop.
PITTCON 2001, Abstracts, p 1349, 2001

For environmental samples, XRF has been limited to the analysis of heavy metals in soil. Although water samples are taken and analyzed at hazardous waste sites, ground-water and well-water samples are generally at low ppb levels, and XRF without sample pretreatment is limited to low ppm levels. Liquid samples allow either direct analysis with or without internal standards, or a concentration approach. With the latter approach, the samples can be evaporated and concentrated to analyze ppb levels, or ion exchange can be used to concentrate various components. With simple sample pretreatment (ion exchange resin to concentrate), low ppb levels of many heavy metals can be detected in water, e.g., 10 ppb Pb in drinking water. The authors discuss methods to optimize the pretreatment technique and evaluate the range, precision, and accuracy with reference to AA or ICP methods.

Rapid On-Site Analysis of Arsenic in Groundwater using a Microfabricated Gold Ultramicroelectrode Array
Feeney, R.; S.P. Kounaves, Tufts Univ., Medford, MA.
Analytical Chemistry, Vol 72 No 10, p 2222-2228, 2000

Rapid on-site analysis of arsenic in ground water was achieved with a small battery-powered unit in conjunction with a microfabricated gold ultramicroelectrode array (Au-UMEA). The sensor, consisting of 564 UME disks and providing a unique gold surface created by electron beam evaporation, was demonstrated to be highly sensitive to low-ppb As3+ using square wave anodic stripping voltammetry. Researchers investigated the influence of the square wave frequency, pulse amplitude, and deposition potential on the arsenic peak stripping current. Varying those theoretical parameters yielded results surprisingly similar to those for the thin Hg film case. The performance of the Au-UMEA was evaluated for reproducibility and reliability. Three stability tests showed an average relative standard deviation of 2.5 % for 15 consecutive runs. Limits of detection were investigated, and 0.05 ppb As3+ could be measured while maintaining a S/N of 3:1. Interference studies were performed in the presence of 50 to 500 ppb of Cu, Hg, and Pb. On-site analysis of arsenic-contaminated ground water was performed with a small battery-powered potentiostat. Quantification done through standard additions yielded results that then were compared to the standard EPA methodology.

Rapid Screening of Solid Samples for Mercury Using Pyrolysis Option with Portable Mercury Analyzer with Zeeman Correction
Markelov, Michael (Ohio LUMEX Co., Cleveland, OH); S. Sholupov; D. DeChant; O. Bershevits.

PITTCON 2001, Abstracts, p 1298, 2001

This paper presents a simple technique for the rapid estimation (<1 min) of mercury content in solids, semi-solids, and liquid samples (<100 mg) at ppb/ppm levels. The instrument cell attaches easily to a portable Atomic Absorption Mercury Analyzer (RA-915+). The instrument also possesses its own 10 m multi-pass cell for air monitoring at ppt levels. The selectivity of the method for mercury is greatly enhanced using Zeeman correction. The products of pyrolysis can easily be re-routed into this high sensitivity cell if needed. The repeatability of the technique is better than 10 % RSD. The methodology has been used successfully for the analysis of Hg in soils and polymers.

Real-Time Measurements of Gaseous Pollutants Using Cermet Sensors
Meshkov Natalia K. (Argonne National Laboratory, Argonne, IL); L. Skubal; M. Vogt.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 142, 2002

DoD needs to identify and characterize emissions of trace air toxic compounds, especially persistent organic pollutants, from operations/activities at its facilities to perform environmental risk assessments. Currently, the collected ambient air toxic concentration data are non-temporal and non-spatial, and produce low quality emission factors. The researchers are developing a new characterization technique--cermet (ceramic-metallic) electrocatalytic “smart” microsensors--to produce nearly instantaneous pollutant concentration profiles of emissions from both stationary and mobile sources. The work involves miniature sensors and portable sensor arrays capable of rapidly detecting and characterizing trace air toxic compounds in near-real time. Results are presented on detecting benzene, 1,3-butadiene, acetaldehyde, and acrolein at several concentrations, singly and in combinations, using cermet microsensors specifically tailored to monitoring emissions in near-real time.

Real Time Monitoring of NAPL Sources Using Photon Attenuation Techniques on Chlorinated Solvents
Gago, Jose L.; Gareth Middleton; Edward H. Hill III; I. Tissa, Colorado School of Mines, Golden.
GSA 2002 Denver Annual Meeting, 27-30 October 2002. Geological Society of America, Paper No. 83-7

Slow dissolution of nonaqueous-phase liquid (NAPL) trapped within aquifer soils provides long-term sources of ground-water contamination. In heterogeneous media, NAPL is entrapped as pools with high NAPL saturation and dissolution occurs predominantly at interfaces between pools and bulk aqueous phase. In most modeling and dissolution studies of dense NAPL (DNAPL) source zones containing pools, it has been assumed that the saturation distribution within the pools is homogeneous, when in reality the saturation within the pool changes with depth. One of the most significant problems in source depletion characterization in experimental studies has been the absence of a technique for noninvasive study of this zone to avoid physical changes of the source as well as the flow field. An ongoing research project uses two photon attenuation measurement devices (x-ray and Gamma-ray) to obtain the changing saturation distribution in source zones containing pools undergoing natural as well as surfactant-enhanced dissolution for the purpose of evaluating the capability of existing modeling methods to predict mass transfer from pools. As the process of mass transfer from pools occur at very slow rates, monitoring of spatial and time distribution of saturation changes require automation. This paper presents the development and testing of an automated dual-gamma system to measure NAPL saturations from a pool during dissolution. Measurement accuracy is compared with another photon-attenuation technique based on x-rays.

Recent Development and Field Tests of a Field Portable ABF-LIPS
Cheng, Mengdawn (Oak Ridge National Laboratory, Oak Ridge, TN); Bryan Harre; Leslie Karr.

Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 140, 2002

The concept of using aerosol beam focused laser induced plasma spectrometry (ABF-LIPS) to measure toxic metals in aerosol particles was conceived and developed through support of the Strategic Environmental Research and Development Program (SERDP). The technique enables sampling of aerosol particles by a shaped nozzle and is able to concentrate the particles prior to initiating laser-induced breakdown. This process results in an enhanced LIPS signal. The technique was awarded U.S. patent # 6,359,687 in 2002. A prototype ABF-LIPS instrument has been developed on a mobile platform. The prototype was modified from a bench-scale unit rather than being a fully engineered compact unit. One person can transport and operate the prototype in field applications. During the latest field test, the instrument was located immediately next to the exhaust stack of a waste incinerator. The exhaust stack was hot and the moisture content of the stack gas was high. A dilution tunnel technique reduced the temperature and removed moisture from the exhaust gases. The tunnel also served as a manifold for co-located filter sampling. Conventional filter samples were taken and subsequently analyzed in the laboratory to provide a reference comparison to the ABF-LIPS measurements. It took four trained technicians to operate the filter sampling train and collect/transfer the samples to the lab, whereas a single person operated the ABF-LIPS instrument and produced real-time data. This presentation describes the latest field work with this instrument and presents the data obtained. The authors also present our latest improvements in size and weight reduction of the prototype and discuss alternative development of a low-cost ABF-LIPS. The Environmental Security Technology Certification Program (ESTCP) is currently supporting the field test and demonstration of the ABF-LIPS technique.

Recent Developments of the Continuous Flow Immunosensor
Shriver-Lake, Lisa C. (Naval Research Lab, Rockville, MD); P.T. Charles; P.R. Gauger; D.B. Holt; C.H. Patterson Jr.; A.W. Kusterbeck.
PITTCON 2001, Abstracts, p 1373, 2001

Cleanup and remediation crews at sites contaminated with TNT and/or RDX need a rapid, quantitative, on-site analysis technique to measure explosive concentration, with a limited number of samples being analyzed and confirmed in the laboratory. A continuous flow immunosensor has been developed for the on-site detection of explosives in ground water. The sensor is based on a displacement fluoroimmunoassay. Since the initial studies in which low ppb levels of TNT and RDX were detected in on-site samples, the continuous flow immunosensor has been used to analyze soil extracts, and studies of solid phase extraction methods to reduce matrix effects have been conducted. Results of these studies, application of the technique to other environmental issues, and methods to improve sensitivity levels are discussed.

Sediment Extraction Using Deposit-Feeder Gut Fluids: A Potential Rapid Tool for Assessing Biaccumulation Potential of Sediment-Associated Contaminants
Weston, Donald P. (Univ. of California, Berkeley); R.N. Millward; L.M. Mayer; I. Voparil; G.R. Lotufo. Prepared in collaboration with Analytical Services, Inc., Vicksburg, MS and Univ. of Maine, Walpole, ME.
Report No: ERDC/EL TR-02-18, NTIS: ADA404026, 38 pp, Jul 2002

Extraction of contaminated sediments using gut fluids from invertebrates can help estimate the biologically available fraction of contaminants. This report discusses how the technique might be used to estimate contaminant bioaccumulation. The method has potential as a universal bioaccumulation screening tool in the testing of dredged material. The report details the current status of the field and both the methods and theory of gut fluid extraction, discusses factors that exert significant influences

upon gut fluid extraction efficiency, compares the method with other measurements of bioavailability, identifies current research needs, and discusses how the technique might be applicable to the needs of the EPA and U.S. Army Corps of Engineers for a universal screening tool for sediment-associated contaminants in dredged material.
http://handle.dtic.mil/100.2/ADA404026

A Selective Chromogenic Reagent for Cyanide Determination
Ros-Lis, Jose V.; Ramon Martinez-Manez; Juan Soto.
Chemical Communications, No 19, p 2248-2249, Oct 2002

A chromogenic reagent for cyanide determination in water has been developed based on the reaction of this anion with a squaraine derivative functionalized with ether chains.

Semi-Automated Fast Mineral Identification Algorithm for Ultraviolet, Visible and Near Infrared Reflectance Spectroscopy
Montero, S.; C. Irene; George H. Brimhall, Univ. of California, Berkeley.
Annual Conference of the International Association for Mathematical Geology, 6-12 September 2001, Cancun, Mexico. 14 pp, 2001

Identification and mapping of surface minerals illustrate and clarify the geochemical processes responsible for their spatial distribution. When the geochemical processes are of such a nature that efficient and fast mineral mapping is crucial, reflectance spectroscopy of the ultraviolet, visible and infrared regions of light is an ideal method for this purpose. A fast identification algorithm for reflectance spectra was developed for identification of minerals that show absorption features in reflectance spectra covering the 0.35 to 2.5 micrometers range. The algorithm uses field-acquired files containing intensity of reflected light as a function of wavelength, and derives basic information about spectral features before comparing these features to a library of reference spectra. The reference spectral library was created from laboratory spectra of selected and well-characterized endmember and mixture samples, whose spectral features were defined in a similar manner that for subsequent unknowns. Spectral absorption (band) characterization starts by fitting line segments over the spectrum to create a continuum or upper hull, which is removed by division. Processing of the continuum-removed spectrum proceeds with smoothing with a Savitsky-Golay least squares filter and computation of first and second derivatives. The window first sizes for the smoothing filter, and second derivatives are pre-assigned based on the known spectral features of the bands of interest. Spectral parameters such as band center, bandwidth, bandwidth at half maximum, and band symmetry are found using the first and second derivatives. These parameters are compared to similarly acquired band information from the various reference spectra and a similarity vector is generated for each comparison. Mineral identification results from the minimization of the similarity vector. Mineral identification is output as text files, which is then used by a real-time digital mapping system to create surface mineralogy maps contemporaneously with survey progress. Minerals easily identified by this method include iron minerals, such as sulfates, oxihydroxides and oxides, and clays.
http://eps.berkeley.edu/groups/erc/abstracts.htm

Sensor Technology Information Exchange (SenTIX)
Stacey Kingsbury, Stacey, WPI, Blacksburg, VA.
Partners in Environmental Technology: 2002 SERDP & ESTCP Symposium & Workshop, 3-5 December 2002, Washington, DC. Poster Abstracts, p 38, 2002

SenTIX (www.sentix.org) is the result of a research initiative to build an Internet portal for information on innovative sensors used primarily for the detection and monitoring of environmental contaminants. Sensors offer an alternative to traditional data collection technologies and methodologies that can be time consuming, expensive and complex by providing accurate, inexpensive, real-time in situ analysis for environmental site characterization and monitoring and. Although the advantages of using sensors for characterization and monitoring may seem obvious, locating information on these sensors may not always be easy. SenTIX was designed to help environmental decision makers, researchers, and others find relevant information on sensors in one place instead of having to perform numerous or lengthy searches. SenTIX offers a searchable database of sensor-related information developed through research and information submittals from SenTIX users. The database is organized into the following categories: research and development, government reports and documents, news, events, and representative commercially available sensor technologies. Online visitors can search this database by text string, contaminant, media, or sensor type. Each search returns results that include journal citations, abstracts with hyperlinks to web sites, and contact information. SenTIX offers users the opportunity to share information on sensor innovations, research, and development; to participate in a sensor-related discussion forum; to read sensor related news; and to locate sensor-related conferences and events. SenTIX is funded through a cooperative agreement between WPI, a nonprofit corporation affiliated with Virginia Polytechnic Institute and State University, and the U.S. Environmental Protection Agency.

Software Solution for Real-Time Decision Making Intelligence for Portable Field Sensors
Lu, K.T. (Atomic Engineering Corp., Gaithersburg, MD); Dennis Baba; Tom Leffler.
PITTCON 2001, Abstracts, p 1379, 2001

Researchers at Atomic Engineering Corp. (AEC) have developed a prototype software solution capable of integrating a vast amount of laboratory data and performing real-time decision-making. Users can integrate data from laboratory sensors with in situ field apparatus for real-time calibration. Real-time decision-making is made possible by efficient algorithms that perform fast analysis and determine concentration. This feature greatly enhances the performance of the field sensors. The power of the software has been illustrated with examples of RCRA trace elements in synthetic silicate and limestone and stream sediments soil samples measured by laser induced breakdown spectrometer. Because the sensitivity of detection limit of certain element is masked by the environmental matrix effect in the soil sample generated by the laser induced plasma, it is essential to calibrate the detector with databases under field matrix conditions. Two databases with these data files as input are created using the software system. The database files are determined by calibrating the selected "fingerprints" of the analyte relative to AEC's reference database. These database files can be loaded by the search program at any time for comparison to determine the detection limit to achieve real-time calibration. The software system is capable of combining, integrating, and analyzing the laboratory data, data from portable field detectors, and other database information. The efficient algorithms can carry out data logging, searching, real-time calibration, and decision-making in just a few steps. The combination of improved software and the advanced algorithms makes possible the real-time analysis of trace elements in soil samples from portable field sensors.

Solid Phase Characterization for Metal Mine Waste Drainage Quality Prediction
Lapakko, K., Minnesota Dept. of Natural Resources, Hibbing, MN. 2003 SME Annual Meeting and Exhibit, 24-26 February 2003, Cincinnati, Ohio. Society for Mining, Metallurgy, and Exploration, Littleton, CO. CD-ROM, 2003

Static tests estimate the capacity of mine waste to produce and neutralize acid and are used as tools for predicting metal mine-waste drainage quality. This paper addresses the various methods and resulting accuracies. More accurate quantification of the capacities, as well as availability and reactivity, may be necessary to predict drainage quality from some mine wastes. Chemical analyses, x-ray diffraction, optical microscopy, scanning electron microscopy, and electron beam analyses are among the techniques commercially available to more accurately quantify these capacities and provide insight into availability and reactivity.

Total Cyanide Determination of Plants and Foods Using the Picrate and Acid Hydrolysis Methods
Haque, M. Rezaul; J.H. Bradbury.
Food Chemistry, Vol 77 No 1, p 107-114, May 2002

A general method has been developed for determination of the total cyanide content of all cyanogenic plants and foods. Ten cyanogenic substrates (cassava, flax seed, sorghum and giant taro leaves, stones of peach, plum, nectarine and apricot, apple seeds, and bamboo shoot) were chosen, as well as various model compounds, and the total cyanide contents determined by the acid hydrolysis and picrate kit methods. The hydrolysis of cyanoglucosides in 2 M sulfuric acid at 100 degrees C in a glass-stoppered test tube causes some loss of HCN, which is corrected for by extrapolation to zero time; however, the picrate method is found to be more accurate and reproducible than the acid hydrolysis method using model compounds (e.g., replicate analyses on amygdalin). The picrate kit method is available free of charge to workers in developing countries for determination of cyanide in cassava roots and cassava products, flax seed, bamboo shoots, and cyanide-containing leaves. The acid hydrolysis method is generally applicable to all plants, but is much more difficult to use and is less accurate and reproducible than the picrate method, which is the method of choice for plants of importance for human food.

Towards Quantitative Analysis of VOCS Traces in Air with PDMS/Carboxen SPME Fibers
Tuduri, Ludovic (Ecole des Mines); Valerie Tuduri; Jean-Louis Fanlo.
PITTCON 2001, Abstracts, p 353, 2001

SPME is a fast, sensitive and solventless sampling technique for air and gaseous effluents that does not need any specific equipment. When coated with PDMS/Carboxen, it shows interesting preconcentration factors. This work was undertaken to check the ability of PDMS/Carboxen SPME fibers for the quantitative analysis of VOC traces in air samples. Eleven model compounds were chosen according to their industrial use and the diversity of their physicochemical properties. The study of sorption kinetics, in dynamic mode, demonstrated that the equilibrium state was never reached because of the competitive sorption and displacement effects. To investigate these phenomena and to check if quantitative analysis was possible, calibration curves were plotted for isolated and mixed compounds at different sampling times. By shortening them, displacement effects were highly reduced. Calibration curves became straight lines, and slopes for isolated and "in mixture" compounds were comparable. Limits of detection increased: for Butyl Acetate, it rose from 20 ng/cubic meter (45 min sampling) to 60 ng/cubic meter (5 min sampling). Repeatability was good (2-6%), regardless of chosen sampling time. Conclusions from these experiments helped determine ground rules for air sampling with PDMS/Carboxen fibers and showed quantitative analysis to be feasible.

Ultramicroelectrode Arrays Modified With Ionomer-Entrapped Silica Films as Potential Voltammetric Sensors for Cu, Pb and Se
Kounaves, S.P. (Tufts Univ.); O.Y. Nadzhafova; V. Tarasov; S.H. Tan.
Analytical Sciences (Supplement - Proceedings of IUPAC ICAS 2001), Vol 17, p 1031-33, 2001

Composite silica-polyelectrolyte thin films obtained by the sol-gel technique were used as surface modifiers for gold-based ultramicroelectrodes (UME) and gold and iridium based UME arrays

(UMEA). Poly(dimethyldiallylammonium chloride) (PDMDAAC) and polyvinylsulfonic acid (PVSA) were used as polyelectrolytes. The best response for the electrodes modified with a composite film was seen for film thickness of 0.7-0.9 mm and a polyelectrolyte content of 1-2%. Silica-polyelectrolyte modified gold-based UMEs were useful for determining trace levels of copper (II) via CV with a detection limit of $5x10^{-6}$ mol/L and for selenium(IV) by SWASV at 10^{-9} mol/L levels. A mercury-coated iridium-based UMEA covered with PVSA-silica composite film was used for lead (II) determination by SWASV. Silica-polyelectrolyte composite films increased selectivity for analyte determination and protected the surface of the electrodes from degradation, thus enhancing the lifespan of the electrode.

Use of Cone Penetrometer Testing and Ultraviolet-Induced Fluorescence to Delineate Subsurface Hydrocarbons
Waclawczyk, Randy R. (McCulley, Frick & Gilman, Inc.); William R. Keffer (Gardere & Wynne, LLP), Jeffrey C. Thomas.
Fifth International Petroleum Environmental Conference: Environmental Issues and Solutions in Petroleum Exploration, Production and Refining, 20-23 October 1998, Albuquerque, NM.
University of Tulsa, OK. p 307-323, 1998

Cone Penetrometer Tests (CPT) with ultra-violet induced fluorescence (UVIF) are invasive techniques used to evaluate the subsurface geologic and engineering properties of soils and identify the presence of hydrocarbon constituents in soil and ground water. CPT technology has been used to evaluate soil engineering and geologic properties by measuring the ratio of the tip resistance to the sleeve friction. UVIF is typically used to identify the presence of hydrocarbons by directing high energy ultraviolet light through a sapphire window, which causes fluorescence of hydrocarbons in the subsurface. The emitted fluorescence is analyzed for both amplitude and wavelength spectrum with a light spectrometer. CPT and UVIF borings successfully identified the horizontal and vertical extent of two subsurface hydrocarbon plumes approximately 13.5 and 3 acres in area to depths of approximately 30 feet in unconsolidated sediments. A limited number of modified Geoprobe borings, hollow-stem auger soil borings, and monitoring wells confirmed the extent of hydrocarbons. The use of CPT and UVIF technologies decreased the time required to investigate the hydrocarbon plumes, decreased the site investigation costs, and provided an extensive database that was used subsequently to evaluate remedial alternatives.

Use of UV/VIS/IS Spectroscopy to Characterize Mine Waste Dumps in the Penn Mine, Calaveras County, California
Montero Sanchez, I.C.; G.H. Brimhall; C. Alpers.
Annual Meeting of the Geological Society of America. Abstracts with Programs, Cordilleran Section meeting, Vol 31 No 6, p A-91, 1999

Abstract not available.

Using Open-Path Optical Remote Sensing to Locate and Quantify Gaseous Emissions from Landfills
Harris, D. Bruce, U.S. EPA, Office of Research and Development (harris.bruce@epa.gov).
7th Annual Landfill Symposium Proceedings. Solid Waste Association of North America, 17-19 June 2002, Louisville, Kentucky.

Abstract not available.

Voltammetric Measurement of Arsenic in Natural Waters

Feeney, R.; S.P. Kounaves.
Talanta, Vol 58, p 23-31, 2002

There are several EPA-approved methodologies for the determination of arsenic in ground water. Such technologies are lab-based, time intensive and can lead to a large capital cost for multi-sample analysis. In light of the number of sites found to contain arsenic at levels higher that the maximum contaminant level (MCL), on-site screening and monitoring systems are an attractive alternative to lab-based methods. This article provides several examples to illustrate the breadth of work in voltammetric analysis of arsenic in environmental samples. The examples include recent voltammetric results obtained with a microfabricated gold array and a field-portable potentiostat at an arsenic-contaminated site in southern New Jersey.

Water Quality Monitoring Using a Portable Fiber Optic Biosensor: RAPTOR
Anderson, George P., Naval Research Lab., Washington, DC.
PITTCON 2001, Abstracts, p 826, 2001

The RAPTOR is a hand-portable automated biosensor capable of performing rapid (ten minute) assays on a sample for four target analytes simultaneously. It performs a fluorescent sandwich immunoassay on the surface of short polystyrene optical probes. The capture antibody is adsorbed to the probe surface, while fluorescently labeled antibodies are held in a separate reservoir. Since target recognition is a two-step process, selectivity is enhanced, and the optical probes can be reused up to forty times, or until a positive result is obtained. This greatly reduces the logistical burden for field operations. Numerous assays for toxins (SEB and ricin) and bacteria (*B. anthracis* and *F. tularensis*) have been developed for the RAPTOR. Detection of *Giardia* cysts is an assay of particular interest for water quality monitoring and the screening of fruits and vegetables. *Giardia lambilia* is a parasitic protozoan that can cause a severe intestinal infection; it is common in the developing world. A simple assay that can be used to screen water supplies in the field has been developed using the RAPTOR. The detection limit for Giardia cysts was $5x10^4$/ml for a 10-minute assay.