SEVENTH MEASUREMENT AND MONITORING LITERATURE UPDATE

$^{13}C/^{12}C$ Isotope Fractionation of Aromatic Hydrocarbons to Characterise Microbial In Situ Degradation
Richnow, H.H.; E. Annweiler; W. Michaelis; R.U. Meckenstock, Inst. fur Biogeochemie und Meereschemie Univ. Hamburg. European Geophysical Society (EGS) XXV General Assembly, 25-29 April 2000, Nice, France. Geophysical Research Abstracts, CD-ROM, Volume 2, 2000

The concentration and the isotopic composition of contaminants in a polluted aquifer was used to characterize in situ biodegradation by calculating the contribution of microbial degradation to the total contaminant removal using laboratory-derived compound specific C-13/ C-12 isotope fractionation factors. The researchers evaluated a contaminant plume 800 meters long and estimated that more than 98% of toluene and o-xylene were removed by in situ biodegradation. Isotope fractionation of contaminants can be used to evaluate in situ biodegradation in the context of intrinsic bioremediation and natural attenuation studies.

Abandoned Mine Site Characterization and Cleanup Handbook
Ceto, Nick (U.S. EPA, Region 10, Seattle, WA); Shahid Mahmud (U.S. EPA, OSWER, Washington, DC). Report No: EPA 910-B-00-001, 129 pp + 280 pp appendix, Aug 2000

The Handbook is the result of the collective efforts and contributions of individuals from around the country, though primarily staff in EPA Regions 8, 9, and 10. The document begins with an overview of mining and mineral processing operations and environmental impacts resulting therefrom. Scoping studies of mining and mineral processing impact areas, sampling and analysis of impacted areas, scoping and conducting ecological and human health risk assessments at Superfund mine waste sites, and remediation and cleanup options also are covered. The last chapter offers an overview of the laws and regulations that affect the cleanup of mine sites. In a separate volume, the 13 extensive appendices include, in part, an extensive bibliography on acid mine drainage; the use of X-ray fluorescence for sample analysis; risk assessment scoping, problem formulation, and additional risk assessment guidance; information on mine remediation technologies such as capping, containment, constructed wetlands, bioremediation, and bioreclamation; and an overview of the EPA/DOE Mine Waste Technology Program. The report is available from the National Service Center for Environmental Publications as a paper report-- EPA 530-R-01-002-- or on CD-ROM under document number EPA530-C-01-001. It also can be acquired (with some difficulty) through the Web, though it may load very slowly.
http://yosemite.epa.gov/R10/CLEANUP.NSF/9f3c21896330b4898825687b007a0f33/f4724f10ccdc2f4d8825699a007861dd?OpenDocument

Abandoned Underground Storage Tank Location Using Fluxgate Magnetic Surveying: A Case Study
Van Biersel, Thomas P.; Bill C. Bristoll; Robert W. Taylor; James Rose. Ground Water Monitoring & Remediation, Vol 22 No 1, 2002

In 1993, during the removal of a diesel and a gasoline underground storage tank, soil testing revealed hydrocarbon contamination at the site, and further investigation indicated the possibility of a second on-site source of petroleum contamination. Limited historical data and the ongoing use of structures within the suspected source area precluded the use of most invasive sampling methods and most geophysical techniques. A fluxgate magnetometer survey identified nine possible magnetic anomalies within the 18225 m area. Subsequent excavation near the anomalies found five paired and two individual 2000 L underground storage tanks. The fluxgate magnetometer survey, although affected by the proximity of buildings, was able to detect the buried tanks within 3 meters of the brick structures, using a 1.521.5 m sampling array.

Ability of a Bacterial Luminescent Reporter to Colonize and to Survive in Soil With and Without a Mercury Stress
Martins, J.M. (LTHE UMR CNRS-UJF1, Grenoble); S. Nazaret (LEM UMR CNRS-UCB, Lyon).
European Geophysical Society (EGS) XXVI General Assembly, 25-30 March 2001, Nice, France.
Geophysical Research Abstracts, Volume 3, 2001. CD-ROM

Work was undertaken to construct a bacterial reporter of bio-available mercury in natural soils that could be efficient in various physical conditions (wet/dry soils, heavily/lightly polluted soils, static/dynamic conditions), and in various soil compartments (inner and outer compartment corresponding to the micro- and macro-porosity). An existing gene fusion between part of the mer operon (mer Ro/pT') and the lux (CDABE) reporter system, was transferred to a soil bacteria, *Agrobacterium tumefaciens* C58 GMI 9023. Physiological and population dynamic studies were carried out and confirmed that the bio-reporter is able to colonize and survive in a sterilized brown leached soil from France to a level of 5.10 7 cell g -1 in both clean and mercury-spiked microcosms; however, in the presence of mercury, bio-reporter growth was prevented in the outer compartment of the soil. The biosensor survived only in the Hg "protected" inner compartment. An attempt to increase cell colonization of the inner compartment based on a wetting/drying cycles approach failed because of the observed destruction of soil structure that led to a lower population level of the biosensor in both inner and outer compartments. This biosensor is currently applied in soil studies to characterize the amount of mercury available to microorganisms.

Accelerated GC/MS Analyses of Samples from Former Manufactured Gas Plant Sites
Mauro, D.M.; S. Smarason; A. Robbat, Jr., Electric Power Research Institute. Report No: EPRI TR-114786, Mar 2000

The Electric Power Research Institute (EPRI) has developed chemical analysis methods for use in generating data quickly and cost-effectively for site characterization and remediation at manufactured gas plant (MGP) sites. This report presents results from a laboratory demonstration of sample preparation and analysis method for rapid determination of polycyclic aromatic hydrocarbons (PAHs) in soil.

Accounting for Cyanide and Its Degradation Products at Three Nevada Gold Mines: Constraints from Stable C- and N-Isotopes
Johnson, Craig A.; David J. Grimes; Robert O. Rye, U.S. Geological Survey, Denver, CO. USGS Open-File Report 98-753, 16 pp, 1998

An understanding of the fate of cyanide (CN-) in mine process waters is important for addressing environmental concerns and for taking steps to minimize reagent costs. The utility of stable isotope methods in identifying cyanide loss pathways has been investigated in case studies at three Nevada gold mines.
http://geology.cr.usgs.gov/pub/open-file-reports/ofr-98-0753/

Acid Mine Drainage in Northern Ontario
Gamey, T.J.

Geologic Applications of Gravity and Magnetics: Case Histories. Society of Exploration Geophysicists, Tulsa OK. SEG Geophysical Reference Series, No. 8, and AAPG Studies in Geology, No. 43, p 112-113, 1998

A helicopter-borne 3-frequency system was deployed to map a plume extending over 2000 feet from a tailings pond. The sensor was slung 30 to 45 meters above the ground, and survey lines were spaced 200 meters apart. The plume had conductivity of ~5mS/m in a background of ~1mS/m. The size of the plume made it economical to use airborne, rather than ground, EM methods to trace it.

Activity Monitoring for Nitrifying Bacteria by Fluorescence In Situ Hybridization and Respirometry
Kim, In S.; Sungyoun Kim; Am Jang, Bio-Environmental Engineering Laboratory (BEEL), Kwangju Inst. of Science and Technology, Buk-Ku Kwangju, Korea. Environmental Monitoring and Assessment, Vol 70 No 1-2, p 223-231, Jul 2001

The activities of two families of nitrifying bacteria were measured by applied respirometer and fluorescence in situ hybridization (FISH) to monitor nitrogen removal. Oxygen uptake rates (OUR) for *Nitrosomonas* and *Nitrobacter* were separately measured with the dosing of selective inhibitors during respirometric monitoring. The FISH method was applied to analyze microorganism communities. Respirometric measurements were well matched by the FISH result, which described the presence and quantity of each nitrifying bacteria as nitrification proceeded. When coupled with OUR data, FISH could provide valuable information about the nitrogen removal process in wastewater treatment systems.

Airborne Lead Monitor Offers Safety, Efficiency
Plummer, Melissa, U.S. Army Environmental Center.
Environmental Update, Vol 13 No 4, Fall 2001

A new air monitoring system designed to help reduce cost, save time, and improve worker safety during lead-based paint removal was tested at the Construction Engineering Research Laboratory at Fort Lewis, WA, and Aberdeen Proving Ground, MD. The AeroLead system, a near-real-time ambient air monitoring system, combines sampling, extraction, and analysis into one unit, finishing in ten minutes or less a process that once took days. Air samples are taken through an innovative sample filter-detector assembly. The airborne lead is concentrated into a specially designed aqueous phase and analyzed voltametrically. The device relies on an integrated airflow meter to determine air sample volume that in combination with the voltametric results yields an accurate reading of airborne lead concentration. The instrument then automatically resets itself for the next sample. The AeroLead can be programmed to perform up to 20 continuous samples of 10 minutes to 20 hours each. Based on the cost of the National Institute of Occupational Safety and Health (NIOSH) 7082 method, use of AeroLead should reduce costs $9-$30 per sample to 90 cents per sample, a reduction of more than an order of magnitude. The AeroLead is also considerably less labor-intensive than current NIOSH 7082 methods. The total air sample volume and flow rate are quantified, resulting in only a 1 to 2% error in sampling air volume, which is considerably better than the 5% air sampling error of the belt pump and filter assembly used for NIOSH 7082. Contact: Terri Cox, USAEC, (410) 436-6863.

An Analysis of a Thermal Imaging Method for Landmine Detection Using Microwave Heating
Deans, J.; G. Schmithals; L.J. Carter, Univ. of Auckland, Auckland, New Zealand. Journal of Applied Geophysics, Vol 47 No 2, p 123-133, 2001

A land mine detection method based on measuring the differing thermal response rates of the sand above and beside a buried dummy mine has been investigated in laboratory experiments. Differing response rates are created when the sand is heated by a microwave generator, and then cooled by forced convection. In the experimental investigation, a surrogate mine was buried in sands having a water content of 5% and 10%, and in oven-dried sand. Evaporative cooling at the surface of the sand is the main mechanism controlling the surface temperature. When a substitute mine was buried in sand, the temperature response rate of the surface above the mine changes during the heating part of the process. This change is due to a reduction in the rate of evaporative cooling in this region. In moist sand, the surface temperature differences of 1.5˚C between the sand above the mine and the sand beside the mine were measured and a resultant infrared photographic image of the mine was observed. The dry-sand tests indicated some heating of the sand surface by vapor condensation, the effect of which is difficult to interpret since the migration of moisture into the sand cannot be evaluated. Infrared photographs taken during the dry-sand tests show that the location of the mine could be observed where the mine was buried at 2 cm, but not at 3 cm.

Antibody-Based Immobilization of Bioluminescent Bacterial Sensor Cells
Premkumar, J. Rajan (Hebrew Univ. of Jerusalem, Israel), Ovadia Lev; Robert S. Marks (Ben-Gurion Univ. of the Negev, Beer-Sheva, Israel), Boris Polyak; Rachel Rosen (Hebrew Univ. of Jerusalem, Israel), Shimshon Belkin. Talanta, Vol 55 No 5, p 1029-1038, 2001

This paper describes whole-cell luminescent bioreporter sensors based on immobilized recombinant *Escherichia coli*. The sensors were prepared by glutaraldehyde-anchoring of nonspecific anti-*E. coli* antibodies on aminosylilated gold or silica glass surfaces with subsequent attachment of the probe bacteria. Several *E. coli* strains were noted that express luciferase in response to different physiological stress conditions, including heat shock, DNA damage (SOS), fatty acid availability, peroxide, and oxidative stress. The sensors can be used either in continuous operation, one-time disposable use, or multiple use. They are compatible with optical fiber technology. Storage stability of the sensors exceeded five months with no measurable deterioration of the signal. Repeatability on exposure in successive days was <15%, as was sensor-to-sensor reproducibility. Sensitivity and detection limits of the immobilized cells were comparable to that of non-immobilized bacteria.

The Application of 3D Electrical Imaging to Brownfield Site Investigation
Chambers, Jonathon, British Geological Survey. Third BGA Geoenvironmental Engineering Conference, 17-19 September 2001, Edinburgh, Scotland, UK

Recent developments in inversion software and electrical surveying instrumentation now allow the collection and interpretation of 3-D data sets that provide valuable spatial and volumetric information regarding subsurface structures. The method has the added advantages of being both cost-effective and non-invasive. This paper presents a case study in which 3-D resistivity models of industrial waste deposits have indicated waste distributions and volumes. The site also has undergone conventional site investigation procedures and techniques, with the collection of historical records and photographs, as well as cone penetration test, borehole, and trial pit data. The conventional site investigation information has helped to calibrate the 3-D models and to assess the efficacy of the 3-D resistivity imaging technique as a site investigation tool.

Application of a Fiber-Optic NIR-EFA Sensor System for In Situ Monitoring of Aromatic Hydrocarbons in Contaminated Groundwater
Buerck, J. (Forschungszentrum Karlsruhe, Inst. fur Instrumentelle Analytik (IFIA), Karlsruhe, Germany), S. Roth, K. Kraemer; M. Scholz (Univ. Karlsruhe, Inst. fur Hydromechanik, Karlsruhe,

Germany); N. Klaas (Univ. Stuttgart, Inst. fur Wasserbau, Stuttgart, Germany). Journal of Hazardous Materials, Vol 83 No 1-2, p 11-28, 2001

It is possible to design and construct sensors for monitoring apolar hydrocarbons in aqueous matrices by using near-infrared (NIR) evanescent field absorption (EFA) measurements in quartz glass fibers coated with a hydrophobic silicone membrane. A fiber-optic sensor system for the determination of aromatic hydrocarbons in ground water or industrial wastewater has been developed that is suitable for quantitative in situ monitoring of pollutants such as aromatic solvents, fuels, mineral oils, or chlorinated hydrocarbons with relatively low water saturation solubility (typically between 0.01 and 10gl1). The sensor probe is connected via all-silica fibers to a filter photometer to allow even remote analysis in a monitoring well. This portable instrument provides a total concentration signal of the organic compounds extracted into the fiber cladding by measuring the integral absorption at the 1st C---H overtone bands in the NIR spectral range. In situ measurements with the sensor system have been performed in a ground-water circulation well in a tank containing sandy gravel to simulate a ground-water-saturated aquifer contaminated with technical-grade xylene. Over four months, the sensor reliably traced the total hydrocarbon concentration (between 80mgl1 down to the limit of detection, ~200µgl1) in the process water pumped from the well to a stripper column.

Applications of Some New Techniques to Detect Groundwater Contamination at Mine Tailings Dams

Buselli, G.; K. Lu. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 14-18 March 1999, Oakland, California. p 507-516, 1999

Helicopter TEM data covering a large tailings dam and vicinity was inverted to give maps of conductivity at different depths. The maps clearly show a shallow conductivity high over the tailings area, and another nearby high that probably reflects geology. Both highs disappear below 50 m depth. The maps show no obvious AMD plume, however. The authors also made ground SP and IP surveys in an attempt to locate the plume, but these appear to be inconclusive. They suggest that drainage may be taking place along a fault in the electrically resistive (103-105 ohm-m) gneissic bedrock, and they show thin linear conductivity highs in both section and plan views that appear to follow this fault.

Arsenic Speciation in a Contaminated Gold Processing Tailings Dam

Shuvaeva, O.V. (Inst. of Inorganic Chemistry, RAS, SB, Ac. Lavrentyev, Novosibirsk, Russia); S.B. Bortnikova (United Inst. of Geology, Geophysics and Mineralogy, RAS SB, Ac. Koptug, Novosibirsk, Russia); T.M. Korda; E.V. Lazareva. Geostandards Newsletter: The Journal of Geostandards and Geoanalysis, Vol 24 No 2, p 247-252, 2000

In an investigation of the extent of arsenic weathering in a tailings dam, speciation of As in surface and pore waters and pond sediments showed that for gold tailings in the dam, As enrichment took place in the pore water relative to the surface water. In pond sediments, As was predominantly present as residual arsenopyrite and partly as a substance co-precipitated with iron hydroxide. The arsenic release from the sediment results from a reductive dissolution of the arsenopyrite and Fe oxides. In the surface water, arsenate and arsenite are the main arsenic species (arsenate is dominant), but in the pore waters methylation processes play a significant role. Arsenic transport is accompanied by the transformation of As into the less toxic compounds (methylated species) co-existing with the most toxic species (arsenite). http://www.crpg.cnrs-nancy.fr/Geostandards/GN_pdf.v24/msvm110.pdf

Bacteria-Degraders as the Base of an Amperometric Biosensor for Detection of Anionic Surfactants

Taranova, L. (Inst. of Colloid Chemistry and Chemistry of Water, Ukrainian Acad. of Sciences, Kiev, Ukraine), I. Semenchuk, T. Manolov; P. Iliasov (Inst. of Biochemistry and Physiology of

Microorganisms, Russian Acad. of Sciences, Moscow, Russia), A. Reshetilov. Biosensors and Bioelectronics, Vol 17 No 8, p 635-640, Aug 2002

Strains belonging to genera *Pseudomonas* and *Achromobacter* and characterized by the ability to degrade anionic surfactants were tested as potential bases of microbial biosensors for surfactant detection. The substrate specificity and stability of sensor signals were studied for each strain. Substrates tested included carbohydrates, alcohols, aromatics, and organic acids; the maximal signals were observed towards the anionic surfactants. The lower limit of detection for the model surfactant, sodium dodecyl sulfate, was around 1 µM for all the strains.

Bacteriophages as Particle Migration Indicators in Subsurface Environments
Kennedy, Keith G., Univ. of Neuchatel, Neuchatel, Switzerland. TraM'2000: The International Conference on Tracers and Modelling in Hydrology, 23-26 May 2000, Liege, Belgium. International Association of Hydrological Sciences, Houston, TX. IAHS Publication No 262, p 151-158, 2000

Bacteriophages can assist characterization of hydrogeological settings and document contaminant behavior as they emulate viral and facilitated/ assisted transport. This paper reports on field research done in Switzerland in peri-glacial aquifers under natural gradients to 65 m and in a granodiorite shear zone to 1.7 m. Phages had distinct and quantifiable breakthrough. Particle first arrivals were earlier or similar to solutes. Low particle attenuation was in channels discovered in thin (less than 2 m) aquifer layers and in one direction in the shear zone.

Biosensors for Direct Determination of Organophosphate Pesticides
Mulchandani, Ashok (Univ. of California, Riverside), Wilfred Chen, Priti Mulchandani; Joseph Wang (New Mexico State Univ., Las Cruces); Kim R. Rogers (U.S. EPA, Las Vegas, NV). Biosensors & Bioelectronics, Vol 16, 225-230, 2001

Direct, selective, rapid and simple determination of organophosphate pesticides has been achieved by integrating organophos-phorus hydrolase with electrochemical and optical transducers. Organophosphorus hydrolase catalyzes the hydrolysis of a wide range of organophosphate compounds, releasing an acid and an alcohol that can be detected directly. This article reviews development, characterization and applications of organophosphorus hydrolase-based potentiometric, amperometric, and optical biosensors. The researchers have developed several OPH-based biosensors that can determine organophosphate pesticides selectively, rapidly, and directly in a single step. Because the detection involves the conversion of the substrate to a product, the biosensors are reusable. Some of the biosensors have the potential for in situ measurements in the field. The detection limit of OPH-based biosensors could be further improved by either lowering the enzyme KM or increasing the bimolecular rate constant.
http://www.engr.ucr.edu/~wilfred/Bioreview.pdf

The Brookhaven National Laboratory Perfluorocarbon Tracer Technology: a Proven and Cost Effective Method to Verify Integrity and Monitor Long Term Performance of Walls, Floors, Caps, and Cover Systems
Heiser, J.; T. Sullivan, Brookhaven National Lab., Upton, NY. Report No: BNL-52657, 43 pp, Mar 2002

Containment system failures that are detected by monitoring wells downstream of the waste site represent an inefficient approach. The Brookhaven National Laboratory Perfluorocarbon Tracer (PFT) technology can measure performance changes and integrity losses as the cover ages, which allows early

detection of cover failure or pending failure so that repair or replacement can be made before contaminants leave the disposal cell. The PFT technology has been successfully applied to four subsurface barrier problems, one leak detection problem from underground ducts, and one surface cover problem. Testing has demonstrated that the PFTs are capable of accurately detecting and locating leaks down to fractions of an inch. The PFT technology has several advantages over competing approaches. The ability to simultaneously use multiple PFTs separates it from other gas tracer technologies. Using multiple tracers provides independent confirmation of flaw location, helps to clearly define transport pathways, and can be used for confirmatory testing (e.g., repeat the test using a new tracer). The PFT tests provide a direct measure of flaws in a barrier, whereas other measurements (pressure, moisture content, temperature, subsidence) provide indirect measures that need interpretation. The focus of the six PFT demonstrations has been on engineering aspects of the technology while searching for flaws in the barrier. Work remains to be done on the scientific basis for this technology, i.e., determining PFT diffusion rates through various materials (soils and barrier) as a function of moisture content, determining the effects of barometric pumping on PFT flow for cover systems, and determining wind effects on side slopes of cover systems and their impact on PFT performance. It also includes applying models to assist in the design of the monitoring system and the interpretation of the data. The set of demonstrations was performed on small sites (1/4 acre). Future work also needs to consider scaling issues to develop and design optimal techniques for delivery and monitoring of the PFTs.
http://www.osti.gov/gpo/servlets/purl/794044-APGKn5/native/

Carbon Isotope Fractionation During Abiotic Reductive Dehalogenation of Trichloroethene: a New Tool to Estimate Reaction Progress
Schuth, C. (Univ. of Tübingen); J.A.C. Barth (The Queen's University of Belfast); M. Bill; R.M. Kalin.
European Geophysical Society (EGS) XXV General Assembly, 25-29 April 2000, Nice, France.
Geophysical Research Abstracts, CD-ROM, Volume 2, 2000

The interpretation of concentration data alone in contaminated ground water often is insufficient for the evaluation of the efficacy of cleanup operations or proof of the attenuation of contaminants. For instance, a decrease in concentration along the flow-path or at a specific sampling location may be due to sorption and dispersion or changes in flow direction and flow velocity, which means that these processes can mimic true degradation reactions. The researchers studied C-13 data on the reductive dehalogenation of TCE using palladium and zero-valent iron in samples taken from reactive barrier systems in Belfast (Northern Ireland) and Tubingen (Germany). The dehalogenation reaction is associated with strong changes in the C-13/ C-12 ratio of the parent compound and the products. Effects were similar for all samples investigated. The results suggest that compound-specific stable isotope ratios are a valuable tool to proof a degradation reaction and to evaluate the progress of a specific reaction.

Case Histories of Electrical and Electromagnetic Geophysics for Environmental Applications at Active Mines
Carlson, N.R.; K.L. Zonge. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), March 23-26, 1997, Reno, Nevada. p 73-80, 1997

The authors report on using both TEM and CSAMT at several active leach dumps in the southwestern U.S. They provide an example from a copper leach dump, where the 10 ohm-m contour on their cross sections closely coincides with pre-dump topography, now buried as much as 150 feet deep. They found that CSAMT works better than TEM for such an application at depth.

Case Studies of 2D Resistivity Surveying for Soils, Waste Management, Geotechnical, and Groundwater Contaminant Investigations
Bauman, P.D.; M. Lockhard; A. Sharma; R. Kellett. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, 23-26 March 1997, Reno, Nevada. p 261-270, 1997

This paper provides practical case histories demonstrating the use of multiple-electrode DC arrays for civil and environmental engineering applications.

Case Studies of Engineering and Environmental Applications of Induced Polarization Imaging
Slater, Lee (Univ. of Missouri - Kansas City); Andrew Binley (Lancaster Univ., Lancaster, UK); Andreas Kemna (Inst. of Chemistry and Dynamics of the Geosphere, Research Center Juelich, Juelich, Germany). Geophysics 2000: The First International Conference on the Application of Geophysical Methodologies & NDT to Transportation Facilities and Infrastructure, 11-15 December 2000, St. Louis, Missouri. 15 pp, 2000

This paper documents three test studies conducted to evaluate the potential of induced polarization (IP) imaging when structural properties of the subsurface are required. Fundamentally, the IP response depends on microgeometry and mineralogy, as well as fluid chemistry and saturation. IP imaging is a promising tool for mapping lithological contrasts in unconsolidated sediments. However, the range of IP response observed in these sediments complicates lithological interpretation. At one site, high polarization correlates with clayey sediments identified from gamma logging, where the clays are considered disseminated throughout sand/silt/gravel units. Difficulties in lithological interpretation arose at a second site, where the complex sequence of Quaternary sediments permitted no simple relation between clay content and polarization. In a third study, the authors describe the results of IP imaging at a hydrocarbon-contaminated site. The hydrocarbon location is evident from the IP image. Prediction of hydraulic permeability variability from the IP data also was attempted, and the resulting permeability image correlated well with known lithological variability at the site; however, further laboratory work is needed to improve models relating hydrocarbon contamination and hydraulic permeability to electrical parameters.
http://www.modot.state.mo.us/g2000/

Characterization, Monitoring and Sensor Technology Advancement
Tinker Air Force Base website, 2002
http://www.tinker.af.mil/em/tcerr1.htm

Sensors for continuous real-time monitoring of soil gas and ground water for contaminant plume migration are needed for compliance with state and federal regulations. Moreover, the specific needs of the environmental restoration and waste management programs require a new generation of sensors and advanced fieldable instrumentation. Present monitoring methodologies are inadequate to address the multitude of monitoring needs in site characterization, cleanup verification, and post-closure monitoring. The Southwest Tanks Area is the real-world platform that supports the demonstration of innovative sensor technologies. It is an IRP site that is approximately 2.5 acres and consists of 17 underground storage tanks that have leaked fuels and solvents into the surrounding soils and groundwater. The site is contaminated with fuel components as well as solvents such as TCE, and the site is undergoing active remediation using bioslurper/bioventing technology. A cone penetrometer was combined with a Laser Induced Florescence (LIF) system, developed under this program, and field tested at Tinker AFB. The cone penetrometer uses a 15- to 20-ton truck to push a 1.5-inch diameter probe through the soils to ground water. The probe can classify soil type, and identify stratigraphy changes and water-bearing units. The cone penetrometer collects ground-water and soil gas samples through an open sleeve on the probe. The samples can then be analyzed on site using a field GC to provide real time data. The LIF system installed in the cone penetrometer allows for direct reading of the contaminants in the soil and ground water without having to collect a sample through the cone penetrometer and bring it to the surface for analysis. The system uses optical fibers to transmit a tunable laser-generated ultraviolet light to, and any resulting fluorescence from, the subsurface monitoring points. The spectrometer analyzes the resulting light after it interacts with the soil or ground water. The system proved successful in identifying and quantifying fuel contamination (benzene, toluene, and xylene) down to 100 ppm. The system, called a Rapid Optical Screening Tool (ROST), is now commercially available. The Environmental Systems Management, Analysis, and Reporting Network (E-SMART) also is being tested at the site. Many types of sensors have been tested at the Southwest Tanks Area, such as fiber optic sensors, spectra sensors, and solid-state sensors. These sensors were used to demonstrate their abilities to measure aliphatic hydrocarbons, TCE, oxygen, carbon dioxide, barometric pressure, temperature, fluid level, and soil moisture. Many advantages and disadvantages have been noted for each type of sensor, with the solid-state sensors and spectra sensors (those that utilize ultra-violet light and infrared) showing promise. Through the manifold system, automated sampling and analysis is also being conducted using a SRI 8610 gas chromatograph equipped with flame and photoionization detectors. The system was used to test its ability to detect and monitor hydrocarbons in the soil gas as well as to aid in the calibration of the sensors. The equipment was invaluable with regard to determining the accuracy of the sensors; however, for long-term automated monitoring applications the GC appears to be too sensitive in terms of the maintenance and calibration required.

Characterization of a Composite Landfill: a Multidisciplinary Approach
Lanz, E.B.; H. Maurer; A.G. Green. Expanded Abstracts with Biographies, Society of Exploration Geophysicists International Exposition and 67th Annual Meeting, 2-7 November 1997, Dallas Texas. Vol 1, p 776-779, 1997

The scientists deployed seismic tomography to investigate a landfill in Switzerland. Geophones spaced 2 m apart on the surface recorded P-waves from multiple shots. The data, inverted using a tomographic inversion scheme, show the shape of the bottom of the landfill, which is up to 18 m deep. It also shows some internal structure of the landfill. Dump material had a P-wave velocity of about 1400 m/s, and that of the underlying unconsolidated gravel in which the landfill lies was about 1800 m/s. This seismic tomographic method should work for mine dumps as well as for landfills.

Characterization of Inorganic Fraction of Spent Potliners: Evaluation of the Cyanides and Fluorides Content
Silveira, B.I.; A.E. Dantas; J.E. Blasquez; R.K.P. Santos, Chemical Engineering Dept., Federal Univ. of Para, Para, Brazil. Journal of Hazardous Materials, Vol 89 No 2-3, p 177-183, 28 Jan 2002

Spent potliner (SPL) is a solid waste generated by the aluminum industry during the manufacture of aluminum metal in electrolytic cells. EPA lists SPL as a hazardous waste because it contains fluoride and cyanide. The researchers undertook work was to characterize the extent of leaching of cyanides and fluorides from SPL, as a function of the number of years the material was present in an operating electrolytic cell. For all the samples studied, there did not appear to be a correlation between the fractions of fluoride and cyanide leached from the samples and the operating life of the potliner materials.

Characterisation of Landfill Waste and Subsurface Using Electrical Imaging

Pokar, Magdeline (Univ. of Leeds); Loke Meng Heng (Univ. Sains Malaysia) and Lee Chong Yan. Third BGA Geoenvironmental Engineering Conference, 17-19 September 2001, Edinburgh, Scotland, UK

This paper examines the usage of electrical resistivity on a sanitary landfill in Malaysia and demonstrates the successful use of the electrical imaging method to delineate and characterize waste disposal sites. A micro processor-controlled resistivity traversing system (MRT) provided information about the subsurface resistivity distribution, and RIES2DINV inverted the data to provide a geological model of the subsurface. As most contaminated sites tend to lack investigation space, a modified Wenner-Schiumberger array was designed that enabled more measurement points to be made over a limited area. Generally, different parts of a landfill would be in different decomposition stages at the same time. This survey was able to accurately differentiate wastes of different ages based on their resistivity values. It was also able to delineate the waste boundaries by the different resistivity values detected from the bund walls and clay liners. The site was imaged from a depth of 1.3 m to 80 m. The survey also indicated a salt water intrusion area 5 m beneath the landfill.

Chemical and Physical Speciation of Arsenic in a Small Pond Receiving Wastewater from a Goldmine
Sproal, R.; N. Turoczy; F. Stagnitti, School of Ecology and Environment, Deakin Univ., Warrnambool, Vic., Australia. European Geophysical Society (EGS) XXVI General Assembly, 25-30 March 2001, Nice, France. Geophysical Research Abstracts, Volume 3, 2001. CD-ROM

The chemical and physical speciation of arsenic in a small pond that receives wastewater from a gold mine in western Victoria, Australia, has been studied using differential pulse polarography. Distinction between physical states (dissolved or particulate As), oxidation states (As(III) and As(V)) and degree of lability (labile or strongly bound) was achieved by various sample pretreatments. The results are interpreted in terms of the physicochemical properties of the pond at the time of sampling, and with reference to the use of the pond as a settlement dam.

Chemical Signatures of TNT-Filled Land Mines
Jenkins, T.F. (U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH), D.C. Leggett, P.H. Miyares, M.E. Walsh; T.A. Ranney (Science and Technology Corp., Hanover, NH); J.H. Cragin (Draper Lab., Fort Belvoir, VA); V. George. Talanta, Vol 54 No 3, p 501-513, 2001

The equilibrium headspace above several military-grade explosives was sampled using solid phase microextraction fibers and the sorbed analytes determined using gas chromatography with an electron capture detector (GC-ECD). The major vapors detected were the various isomers of DNT, DNB, and TNT, with 2,4-DNT and 1,3-DNB often predominating. Although 2,4,6-TNT made up from 50 to 99% of the solid explosive, it was only a minor component of the equilibrium vapor. The flux of chemical signatures from intact land mines is thought to originate from surface contamination and evolution of vapors via cracks in the casing and permeation through polymeric materials. The levels of external contamination were determined on a series of four types of Yugoslavian land mines (PMA-1A, PMA2, TMA5 and TMM1). Concentrations of signature chemicals varied significantly depending on the type of mine tested.

Chromium Isotopes and the Fate of Hexavalent Chromium in the Environment
Ellis, Andre S. (U.S. Geological Survey, Menlo Park, CA); Thomas M. Johnson (Univ. of IL); Thomas D. Bullen. Science, Vol 295, p 2060-2062, 15 Mar 2002

A straightforward technique for monitoring hexavalent chromium in ground water has been developed by U.S. scientists who can now determine the rate of reduction of hexavalent chromium to trivalent chromium at a given site. The technique relies on the fact that the lighter of chromium's four non-radioactive isotopes has a higher rate of reduction for the hexavalent species. The trivalent chromium essentially becomes enriched in lighter isotopes during reduction, while the remaining hexavalent chromium has higher heavier isotope content. Water samples from a contaminated site can be analyzed quickly. By determining the isotope ratios using mass spectrometry, the team can relate this to the overall rate of reaction and thus the removal of the toxic hexavalent chromium from putative drinking water sources. Reduction rate is determined by the presence of natural reducing agents, such as magnetite. If the concentration of these reductants is high enough, a chromium-contaminated site might be able to reduce the hexavalent level without intervention. But where no naturally-reducing minerals are present, remedial measures such as injecting reductants into the ground are essential to prevent pollution of ground water. It is not yet known whether or not natural sourced chromium and industrially processed chromium have the same relative abundances. If they do, the monitoring process will be even simpler. If they are different, then the fingerprint isotopic ratios could be used to reveal source information, too.

Combined Geophysical Techniques Improve Site Characterization

United States Army Environmental Center. Environmental Update, Vol 13 No 3, Summer 2001

A combination of eight innovative geophysical techniques demonstrated by USAEC will cut the cost of a traditional landfill characterization in half and save six to 12 months in investigation time. USAEC demonstrated the use of combined techniques at Camp Roberts, CA, in May 2000. The data collected from the demonstrations determined the boundaries and characterized the geologic setting of two landfills, one abandoned many years ago and one currently operating under a permit. Both are subjects of a CERCLA site inspection. The lateral extent of the new landfill was successfully defined, and the northern boundary of the older landfill was established. Determining the three-dimensional nature of landfills had proven difficult in the past using conventional geophysical methods, but by comparing the real-time results of the new techniques and then processing and interpreting the data in the field, the USAEC team delineated much greater subsurface detail than usual at the Camp Roberts landfills. Based on further interpretation and refinement of the new techniques, a second phase of geophysical study at Camp Roberts commenced in May 2001 to define the horizontal extent of the old landfill and refine the lateral extent of both landfills. The results of this geophysical study will be used to determine the remediation alternatives that can be applied to the landfills. The total cost of the study will be approximately $250,000, less than half the cost of a traditional landfill characterization.

A Compact Polycapillary-Based Microbeam X-Ray Fluorescence Analysis System for Remote Monitoring of Metal Contamination

Gao, Ning, X-Ray Optical Systems, Inc., Albany, NY. Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia

The researchers have proposed to build a compact polycapillary-based microbeam x-ray fluorescence (MXRF) sensor system based upon an innovative technology polycapillary x-ray focusing optics. The use of the optics on MXRF analysis significantly improves the detection sensitivity, and the greatly increased system efficiency makes it possible to build a compact, low-cost MXRF system for on-site applications such as remote monitoring of RCRA metals in air, water, and soil. The preliminary testing performed in the Phase I of the project has successfully demonstrated the feasibility of the proposed approach, and the results are reported and discussed. The paper also addresses future work planned for Phase II of the project and potential applications of the technology in other industries.

http://www.netl.doe.gov/publications/proceedings/01/indpartner/indpart01.html

Comparison of Eight Innovative Site Characterization Tools Used to Investigate an MTBE Plume at Site 60, Vandenberg Air Force Base, California
Einarson, M.D. (Univ. of Waterloo, Waterloo, Ont., Canada, & Conor-Pacific/EFW, Palo Alto, CA); M. Schirmer (UFZ Centre for Environmental Research Leipzig-Halle, Leipzig, Germany); P. Pezeshkpour; D.M. Mackay; R.D. Wilson. Petroleum Hydrocarbons and Organic Chemicals in Ground Water--Prevention, Detection, and Remediation, 17-19 November 1999, Houston, Texas, Proceedings. National Ground Water Association, and American Petroleum Institute, p 147-157, 1999

At Vandenberg AFB, CA, an accidental release of gasoline containing MTBE in 1994 created a dissolved MTBE plume at least 1,700 feet long. Portions of the aquifer containing the dissolved plume have been characterized in considerable detail in order to assess the occurrence, distribution, and flux of MTBE and other solutes within the dissolved plume. In one area, the geology and plume geochemistry were assessed by collecting continuous stratigraphic and geochemical profiles at 40-foot intervals across the entire width of the MTBE plume. Eight innovative characterization tools were used in the subsurface investigation, providing a unique opportunity to compare and contrast the various characterization tools. The subsurface geology was investigated by collecting and logging continuous soil cores, performing cone penetration test (CPT) soundings, direct-push resistivity probes, Geoprobe electrical conductivity probes, and surface dipole-dipole resistivity surveys. The ground-water geochemistry was assessed by collecting one-time "snapshot" samples using a Geoprobe sealed screen sampler and the Waterloo Groundwater Profiler. The CPT provided the most detailed, cost-effective information about the site stratigraphy. A multi-level monitoring system yielded important information regarding the vertical distribution of hydraulic head in the aquifer and ongoing samples of ground water for geochemical measurements.
http://www.solinst.com/Res/Res.html

Comparison of Field and Laboratory Methods for Monitoring Metallic Mercury Vapor in Indoor Air
Singhvi, Raj (U.S. EPA, Edison, NJ), Rod Turpin; Dennis J. Kalnicky (Lockheed Martin Technology Services Group, Edison, NJ), Jay Patel. Journal of Hazardous Materials, Vol 83 No 1-2, p 1-10, 2001

Real-time metallic mercury vapor levels of the indoor air were monitored at several mercury spill sites around the U.S. Mercury readings taken in the field with a Jerome 431™ Mercury Vapor Analyzer were compared with laboratory analysis using a modified NIOSH 6009 method. Statistical evaluation showed that the data were highly comparable except at low concentrations, due to the large degree of uncertainty associated with measuring low levels of mercury with the Jerome analyzer. Regression analysis indicated that Jerome measurements of 10µg/m^3 or greater are comparable for field analysis of mercury vapor in air.

Complex Electrical Resistance Tomography of a Subsurface PCE Plume
Ramirez, A. (Lawrence Livermore National Lab.), W. Daily; D. LaBrecque (Univ. of Arizona). Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 28 April-1 May 1996, Keystone, CO. Paper No: UCRL-JC-122874, 12 pp, Jan 1996

A controlled experiment was conducted to evaluate the performance of complex electrical resistivity tomography (CERT) for detecting and delineating free-product dense nonaqueous phase liquid (DNAPL) in the subsurface. One hundred ninety liters of PCE were released at a rate of 2 liters per hour from a point 0.5 m below ground surface. The spill was conducted within a double walled tank where saturated layers of sand, bentonite and a sand/bentonite mixture were installed. Complex electrical

resistance measurements were performed from 4 vertical electrode arrays, each with 10 electrodes spaced between 3 m and 0.5 m depth. Data were taken before the release, several times during, and then after the PCE was released. Magnitude and phase were measured at 1 and 64 Hz. Data from before the release were compared with those during the release for the purpose of imaging the changes in conductivity resulting from the plume. Conductivity difference tomographs showed a decrease in electrical conductivity as the DNAPL penetrated the soil. A pancake-shaped anomaly developed on the top of a bentonite layer at 2 m depth. The anomaly grew in magnitude and extent during the release and borehole television surveys data confirmed the anomaly to be free-product PCE whose downward migration was stopped by the low permeability clay. The tomographs clearly delineated the plume as a resistive anomaly. Images showing phase changes caused by the spill are also presented. The phase changes at 64 Hz suggest that the DNAPL spill increased the induced polarization (IP) effect of the clay layers.
http://www.llnl.gov/tid/lof/documents/pdf/228928.pdf

Complex Permittivity Measurement System for Detecting Soil Contamination
Rowe, R.K.; J.Q. Shang; Y. Xie. Canadian Geotechnical Journal/Reviews in Canadian Geotechnology, Vol 38 No 3, p 498-506, Jun 2001

This paper describes the design, calibration, and operation of a laboratory-scale system to assess the viability of detecting contaminants in soil based on changes in its electromagnetic response. The laboratory system can be used routinely to create soil samples permeated with a known contaminant at known concentrations and then measure the complex permittivity of the contaminated soil samples directly after permeation. The system is such that other factors (e.g., density and water content) that could influence the complex permittivity can be carefully controlled, allowing the relationship between the type and level of contamination and dielectric behavior of soils to be established.

Complex Resistivity Characteristics of Pyrite and Clays Altered by Acid-Mine-Drainage Contaminants: Implications for Monitoring of Advancing Contamination Fronts
Gudjurgis, P.; T.J. Katsube; J. Gingerich. Society of Exploration Geophysicists International Exposition and 67th Annual Meeting, 2-7 November 1997, Dallas TX. Expanded Abstracts with Biographies, Vol 1, p 434-437, 1997

This paper describes a laboratory study to predict IP signatures of AMD plumes. The main IP effects were at higher frequencies than are commonly used by present-day IP gear.

Complex Resistivity Tomography for Environmental Applications
Ramirez, Abelardo (Lawrence Livermore National Laboratory, Livermore, CA), William Daily; Andrew Binley (Lancaster Univ., Lancaster, UK); Douglas LaBrecque (Steamtech, Inc., Bakersfield, CA). First World Congress on Industrial Process Tomography, Buxton, Greater Manchester, 14-17 April 1999. p 14-19, 1999

The authors report on laboratory trials of their extensions of electrical resistivity tomography to a complex form. The inversion procedure is presented and demonstrated for two different targets, with resistive and reactive characteristics.
http://www.vcipt.org.uk/congress/proceed.htm

The Continuous Monitoring of Field Water Samples with a Novel Multi-Channel Two-Stage Mini-Bioreactor System

Gu, Man Bock (ADEMRC, Kwang-Ju Inst. of Science and Technology, Kwang-Ju, Korea), Byoung Chan Kim, Jaeweon Cho; Peter D. Hansen (Technical Univ. of Berlin, Berlin, Germany).
Environmental Monitoring and Assessment, Vol 70 No 1-2, p 71-81, Jul 2001

Toxicity monitoring of field water samples was performed successfully using a novel multi-channel two-stage mini-bioreactor system and genetically engineered bioluminescent bacteria for the continuous monitoring and classification of toxic elements in liquids. The toxicity of various samples spiked with known endocrine-disrupting chemicals and phenol was also investigated for system characterization. Field samples were obtained on a monthly basis from a drinking water treatment plant and from a stream near a dam construction site. The samples generally showed no specific toxicity, with only one exception. The samples spiked with phenol showed possible responses in the DPD2540 and TV1061 channels, indicating the occurrence of both membrane and protein damage due to phenol. In the tests using an endocrine disrupting chemical, bisphenol A, DNA damage was detected in the DPD2794 channel with a concentration of 2 ppm. The paper also outlines a simple but novel early warning protocol that can be used in a drinking water reservoir.

Continuous Monitoring for Cyanide in Waste Water with a Galvanic Hydrogen Cyanide Sensor Using a Purge System
Hachiya, Hiromitsu (DKK Corporation, Tokyo, Japan), S. Ito; Y. Fushinuki (Scientific Investigation Research Lab., Kagoshima Pref. Police HQ, Kagoshima, Japan); T. Masadome (Ariake National College of Technology, Fukuoka, Japan), Y. Asano; T. Imato (Kyushu Univ., Fukuoka, Japan).
Talanta, Vol 48 No 5, p 997-1004, 1999

The researchers developed a continuous monitoring system for cyanide with a galvanic hydrogen cyanide sensor and an aeration pump for purging. Hydrogen cyanide evolved from cyanide solution using a purging pump was measured with the hydrogen cyanide sensor. The system performed well in terms of stability and selectivity. The lower detection limit was 0.1 mg dm-3. The 90% response time of the sensor system was within 3.5 min for a 0.5 mg dm-3 cyanide solution, when the flow rate of the purging air was 1 dm3 min-1. The system maintained the initial performance for 6 months in a field test. The developed galvanic sensor system was not subject to interference from sulfide and residual chlorine, and the analytical results obtained by the present system agree well with those obtained by the pyridine pyrazolone method. The system was applied successfully to continuous monitoring for cyanide ions in wastewater.

Cost-Effective Monitoring for a Soil Vapor Extraction (SVE) System: a Simplified Modeling and Gas Sensor Test
Yang, Ji-Won (KAIST, Taejon, Korea); Hyun-Jeong Cho; Gwan-Young Choi; Sang-Hyun Lee.
Environmental Monitoring and Assessment, Vol 70 No 1-2, p 201-210, Jul 2001

This paper surveys recent developments that will help create cost-effective monitoring techniques for soil vapor extraction (SVE) projects, including a simplified model for multi-component mass transfer of a complex liquid mixture in porous media and a gas sensor. Findings are presented from an experimental assessment of the performance characteristics of these techniques. Planners of SVE projects require effective methods for deciding how to estimate the performances of venting systems with respect to the contaminant vapor removal rate and the time needed to realize a given cleanup specification. Analyses of the gas chromatographic profile can help classify the individual components of a complex mixture. Resulting groups are considered as pseudo-single compounds.

Coupling Fiber Optics to a Permeation Liquid Membrane for Heavy Metal Sensor Development

Ueberfeld, Joern; Nalini Parthasarathy; Hugo Zbinden; Nicolas Gisin; Jacques Buffle. Analytical Chemistry, Vol 74, p 664-670, 2002

The authors present a sensing system for metal ions based on the combination of separation and preconcentration by a permeation liquid membrane (PLM), and fluorescence detection with an optical fiber. A model system was developed for the detection of Cu(II) ions. Among five tested heavy metal ions, Pb(II) was the only major interfering species. The incorporation of small silica optical fibers into the polypropylene capillary allows for real-time monitoring of the Cu(II) accumulation process
http://www.gapoptic.unige.ch/Publications/Pdf/ac0156103.pdf

A Critical Review of Ion Mobility Spectrometry for the Detection of Explosives and Explosive Related Compounds
Ewing, R.G. (Idaho National Engineering and Environmental Lab., Idaho Falls, ID), D.A. Atkinson; G.A. Eiceman (New Mexico State Univ., Las Cruces, NM), G.J. Ewing. Talanta, Vol 54 No 3, p 515-529, 2001

Findings from over 30 years of investigations into ion mobility spectrometry (IMS) response to explosives have been collected and assessed to allow a comprehensive view of the atmospheric pressure chemical ionization (APCI) reactions characteristic of nitro-organic explosives. The drift tube conditions needed to obtain particular mobility spectra have been summarized. During the past decade, improvements have occurred in IMS on the understanding of reagent gas chemistries, the influence of temperature on ion stability, and sampling methods. Commercial instruments have been refined to provide fast and reliable measurements for on-site detection of explosives.

The Cyanide Compendium
Mudder, T.I.; Mike Botz, Adrian Smith (eds.).
The Mining Journal Ltd., London, UK. CD-ROM, 2001

This compilation is an essential source of information regarding cyanide and its chemistry, analysis, environmental fate, toxicity, management, recovery, and treatment. The fully searchable and printable CD-ROM contains the contents of four publications: Chemistry and Treatment of Cyanidation Wastes, 2nd edition [in English and in Spanish]; The Cyanide Monograph, 2nd edition [30+ technical papers]; The Management of Cyanide in Gold Extraction (1999); and Best Practice Environmental Management in Mining: Cyanide Management (1998).

Cyanide Ion-Selective Electrode Measurements in the Presence of Copper
Gattrell, M. (Chem. Proc./Environ. Techol. Inst., National Research Council of Canada, Ottawa, Ont., Canada); S.C. Cheng; T. Guena; B. MacDougall. Journal of Electroanalytical Chemistry, Vol 508 No 1-2, p 97-104, 2001

The interferences of metal ions (e.g., copper) on the response of a cyanide ion-selective electrode (ISE) prevents its use for routine direct analysis of metal cyanide-containing wastewater. The authors are striving for an improved understanding of the chemistry at the electrode, and the effects of different cyanide and copper concentrations and matrix pH values on the electrode response. This paper describes a semi-empirical approach to allow calibration of the ISE, enabling the estimation of total cyanide. While not as robust as total cyanide distillation, it provides an inexpensive, rapid and convenient approach for more frequent and widespread screening of industrial wastewaters.

Cyanide Measurement and Chemistry in Wastewater Effluent
Luthy, Richard G., Stanford Univ., Stanford, CA. Stanford Univ., Dept. of Civil and Environmental Engineering web site

A multi-investigator project was launched in fall 1998 to evaluate cyanide measurement and speciation at low levels in chlorinated effluent. The work is evaluating analytical methods for the measurement and speciation of cyanide at the ppb level, and examining the effect of chlorination on possible formation of cyanide at low levels. The collaborators are Malcolm Pirnie, Inc., Clarkson University, and various large municipal wastewater treatment plants across the United States. (with David A. Dzombak)
http://www-cive.stanford.edu/luthy/

DC Resistivity and Induced Polarisation Investigations at a Waste Disposal Site and Its Environments
Aristodemou, E.; A. Thomas-Betts, Royal School of Mines, London, UK. Journal of Applied Geophysics, Volume 44, Issue 2-3, p 275-302, May 2000

Geoelectrical surveys (DC resistivity and time domain induced polarization (IP) methods) carried out to monitor the spread of contamination in aquifers underlying a landfill provided data concerning electrical properties of the aquifers that were used to estimate hydraulic conductivities for modeling contaminant transport. The type of waste deposited and the influence of the geological environment were the crucial factors investigated. The landfill was mainly a liquid disposal site with existing borehole information showing that the waste contained high concentrations of both inorganic (chlorides, sulfates) and organic materials. Resistivity measurements along the survey lines perpendicular to the ground-water flow showed systematic reductions of resistivities relative to the control line, the effect decreasing progressively eastwards from the landfill. The resistivities of these contaminated sections were higher than expected, and one possible explanation for it could be the presence of the organic waste, though alternatively it could be due to the low porosities in the sand formations. The IP measurements showed high apparent chargeability values (80-120 ms) on top of the landfill, possibly due to the presence of disseminated solid metallic waste or the high organic load of the liquid waste disposed. The IP line parallel to the ground-water flow direction and close to the landfill produced chargeability anomalies that may be associated with a plume of organic waste. No chargeability anomalies were observed on the second IP line, further away from the landfill and in the SE direction.

DC Resistivity and IP Methods in Acid Mine Drainage Problems: Results from the Copper Cliff Mine Tailings Impoundments
Yuval and Oldenberg, D.W., Univ. of British Columbia, Vancouver, BC, Canada. Journal of Applied Geophysics, Vol 34 No 3, p. 187-198, 1996

Oxidation of sulfide minerals in the mine tailings impoundments at Copper Cliff, Ontario, generates acid mine drainage (AMD). A combined DC resistivity and induced polarization (IP) survey was carried out along one of the major flowpaths in the tailings and the data were inverted to produce detailed electrical conductivity and chargeability structures of the cross-section below the survey line. The conductivity distributions are directly translated through theoretical and empirical relations to a map of the concentration of the total dissolved solids along the cross-section that allows some insight about the in situ pore water quality. The sulfide minerals are the source of the IP response; when combined with borehole data, the chargeability model can be used to estimate the amount and distribution of the sulfides. DC showed the AMD plume well, whereas IP was inconclusive.

Delineation of Boundaries and Pollutant Plumes at a Landfill Site, London, UK

Aristodemou, E.; A. Thomas-Betts. 59th European Association of Scientists and Geoengineers (EAGE) Conference and Technical Exhibition, Geneva, Switzerland, 26-30 May, 1997 extended abstracts paper F050, 1997

Abstract not available.

Dense Nonaqueous Phase Liquid Tracer Tests: Experimental Results
Burt, Ronald A.; Gregory L. Christians; Samuel P. Williams; David J. Wilson, Eckenfelder/Brown and Caldwell, Nashville, TN. Environmental Monitoring and Assessment, Vol 72 No 3, p 297-326, Dec 2001

Two dense nonaqueous phase liquid (DNAPL) tracer tests were carried out in a shallow aquifer north of Fort Worth, TX, with i-Propanol for the non-partitioning tracer, and n-hexanol and n-octanol as the partitioning tracers. The DNAPL tracer tests were designed with field data, mathematical modeling, the results of column tests, and field tracer tests with NaCl. The results indicated the presence of DNAPL at both sites tested; semi-quantitative estimates of the amounts of DNAPL present were obtained by mathematical modeling. The heterogeneity of the aquifer and mass transport effects complicated interpretation of the results.

Detailed Characterization of a Technical Impracticability Zone Using Drive Point Profiling
Soloyanis, Susan C. (MITRE Corp., San Antonio, TX); M.A. McKenzie; S.E. Pitkin; R.A. Ingleton. Sampling Environmental Media. American Society for Testing and Materials, Philadelphia, PA. ISBN: 08-031204-35, ASTM STP 1282, 1996

A team of geologists and engineers conducted an investigation in a dense non-aqueous phase liquid contaminant (DNAPL) source area at Pease AFB Site 32. The investigation was designed to demonstrate that vertical drive point profiling using techniques and equipment developed by the Waterloo Centre for Groundwater Research would work at the hydrogeologically complex site, and to locate solute concentrations indicative of DNAPL. The original contaminant source at Site 32 was a 1,200-gallon (4500 L) underground storage tank with an overflow discharge pipe. The tank held waste solvents from aircraft maintenance. It was removed in 1988, and the overflow discharge pipe was removed with the contaminated soil in 1990. The Site 32 source area remedial investigation/feasibility study indicated the presence of solvent-related contaminants in soil and overburden and in bedrock ground water, as well as a residual DNAPL source resulting in dissolved-phase ground-water contamination. Efforts to locate DNAPL using monitor wells have been unsuccessful. A drive point profiler was used to obtain 40 discrete interval ground-water samples from a total of five locations in nine days of field work. The drive point profiler enabled sampling of fine-grained, low permeability units in which monitor wells would not usually be installed. Samples analyzed in a mobile laboratory for volatile organic compounds showed trichloroethene, l,2-dichloroethene, and vinyl chloride. The investigation produced useful information about the highly variable distribution of these compounds in the overburden units.
http://www.solinst.com/Res/papers/detail/detail.html

Detecting Leaks from Waste Storage Ponds using Electrical Tomographic Methods
Binley, Andrew (Lancaster Univ., Lancaster, UK); William Daily (Lawrence Livermore National Laboratory, Livermore, CA), Abelardo Ramirez. First World Congress on Industrial Process Tomography, Buxton, Greater Manchester, April 14-17, 1999. p 6-13, 1999

Methods for detecting and locating leaks in lined waste disposal ponds have been established based on injecting electrical current through the liner into the surrounding soil, and then mapping electrical potential with the aid of an under-liner array of electrodes. High potential gradients then reveal the likely location of leak spots within the liner. The approach is very expensive and is not applicable in existing sites where retrofitting is not an option. A tomographic variant of this electrical leak location method has been developed whereby electrical potentials are collected around the perimeter of the site, and then the location of a leak within the pond is computed with suitable data processing. Applications on a controlled lab-scale model and a field-scale test site have shown promising results.

Detection and Analysis of LNAPL Using the Instantaneous Amplitude and Frequency of Groundpenetrating Radar Data
Orlando, Luciana. Geophysical Prospecting, Vol 50 No 1, 27-41, Jan 2002

This paper reports the results of using the ground penetrating radar (GPR) method to detect light nonaqueous phase liquids (LNAPL) floating on the water table in an area where the thickness of LNAPL present ranges from a few centimeters to several decimeters. The study revealed an increase in the reflection amplitude from the water table due to the decrease in the capillary fringe. The amplitude of reflection from the water table can discriminate the contaminated from the uncontaminated zone. Apart from an analysis of the real traces, the analysis of some attributes of the complex trace—instantaneous amplitude, phase, and frequency—are also good tools to detect hydrocarbons floating on the water table. Such attributes can also give information about the thickness of the hydrocarbon layer, depending on both the signal frequency and the hydrocarbon thickness. The author concludes that analyzing the lateral variations in signal amplitude of the real trace and in the amplitude, phase, and instantaneous frequency of the complex signal permits the area polluted by the hydrocarbon to be delimited.

Detection and Delineation of Underground Fuel Storage Tanks and Associated Utility Lines Using Electromagnetic Induction and Ground Penetrating Radar Methods
Brady, Thomas (Univ. of Missouri-Rolla, now at Veritas Geophysical Services, Houston, TX); Steve Cardimona; Neil Anderson. Geophysics 2000: The First International Conference on the Application of Geophysical Methodologies & NDT to Transportation Facilities and Infrastructure, 11-15 December 2000, St. Louis, Missouri. 11 pp, 2000

During demolition of a gas station property, damage can occur to the underground storage tanks (USTs) and associated utility lines. Noninvasive mapping of these features prior to excavation can greatly reduce problems associated with unexpected tank discovery. The proposed expansion of selected highways in Missouri required several gas stations to be demolished. Nonintrusive geophysical methods—electromagnetic induction and ground penetrating radar—were used to map the underground fuel storage tanks and associated utility lines. The complementary use of ground penetrating radar and electromagnetic methods increased the likelihood of detecting subsurface anomalies, because the locations of the existing tanks and associated utility lines can be interpreted in both ground penetrating radar profiles and contoured electromagnetic induction maps. Electromagnetic induction maps provided a useful and cost-effective initial survey for detecting the USTs. Ground penetrating radar proved important for the accurate delineation of the tanks. The integrated use of ground penetrating radar and electromagnetic induction methods allowed engineers to create a map of exact tank locations at each site.
http://www.modot.state.mo.us/g2000/

Detection of Hormone Mimics in Water using a Miniaturised SPR Sensor

Sesay, Adama M.; David C. Cullen, Cranfield Biotechnology Centre, Cranfield Univ. at Silsoe, Bedfordshire, UK. Environmental Monitoring and Assessment, Vol 70 No 1-2, p 83-92, Jul 2001

Chemical hormone mimics or endocrine-disrupting compounds (EDCs) are especially prevalent in surface water and wastewater, and a need exists for an at-source or at-line analytical device to monitor EDC levels. The authors have incorporated a miniature integrated surface plasmon resonance (SPR) liquid sensor from Texas Instruments into a field analyzer and developed a competition/inhibition assay for a model estrogenic compound in aqueous samples. The analyzer has the potential for in situ and semi-continuous analysis of EDCs. A novel regeneration scheme employing a domestic laundry detergent can remove immobilized assay components between each assay cycle. The resultant reusable sensor has been demonstrated using estrone-3-glucuronide (E3G) as a model EDC and an anti-E3G antibody producing a current detection range of 10 to 150 ng mL^{-1}.

Determination of Cyanide by a Pervaporation-UV Photodissociation-Potentiometric Detection Approach
Vallejo-Pecharroman, B.; M.D. Luque de Castro, Dept. of Analytical Chemistry, Univ. of Cordoba, Cordoba, Spain. Analyst, Vol 127 No 2, p 267-270, 2002

An automated system for the determination of total cyanide in water samples has been developed in which stable metal-cyanide complexes are photodissociated in an acidic medium with a UV lamp. The released hydrogen cyanide (HCN) is pervaporated and collected in dilute NaOH solution acting as an acceptor. The cyanide ion is isolated from interferents such as sulfide and determined potentiometrically using an ion-selective electrode. The content of cyanide in three wastewater samples obtained with the new method was compared with the results provided by EPA method OIA-1677 for the determination of total cyanide in water samples. Excellent agreement was obtained in all instances. The method can be applied over a wide range of concentrations (0.4-200 micrograms/L^{-1} CN- and 0.05-50 mg/L^{-1} CN- using injection volumes of 200 and 50 micrograms/L, respectively). The sample throughput of the system is 40 h^{-1} and the detection limit for total cyanide is 0.01 micrograms/L^{-1}.

Determination of Cyanide by an Indirect Spectrophotometric Method Using Formaldehyde and 3-Methyl-2-Benzothiazolinone Hydrazone
Geetha, K.; N. Balasubramanian, Dept. of Chemistry, I.I.T., Madras, Chennai, India. Analytical Letters, Vol 34 No 14, p 2507-2519, 2001

The authors propose a simple spectrophotometric method to determine cyanide based on the reaction between cyanide and formaldehyde-3-methyl-2-benzothiazolinone hydrazone. The method can determine cyanide in the concentration range 0-0.2 ppm with a standard deviation of 3.5% for $n = 10$ at 0.06 ppm of CN-. The calculated molar absorptivity is 4.3104L mol^{-1} cm^{-1}. Response to potential interferents is addressed; the method is practically free from the interference of thiocyanate in the presence of high concentration of nitrite and nitrate. The proposed method has been successfully applied to determine free and total cyanide in effluent samples and in soil taken from a treated cyanide dump, with the results validated with the barbituric acid method and by standard addition.

Determination of Henry's Constant Using a Photoacoustic Sensor
Ueberfeld, Jorn (Univ. de Geneve, Geneva, Switzerland); Hugo Zbinden; Nicolas Gisin; Jean-Paul Pellaux. Journal of Chemical Thermodynamics, Vol 33, p 755–764, 2001

The authors present a simple method for measuring the Henry's constant kH of ethanol using photoacoustic spectroscopy. At $T = 298.1$ K the measured value for kH is (0.877 ± 0.039) kPa·kg·mol-1.

The data show that Henry's law is valid at ethanol molalities between 0.1 mol·kg-1 and 1.4 mol·kg-1. The temperature dependence of Henry's constant was carefully examined by measuring the ethanol vapor pressure of six different aqueous solutions between T = (273.1 and 298.1) K. By analyzing the gas phase concentration and applying Henry's law, an ethanol molality of 0.864 mol·kg-1 in the liquid phase can be measured with an error of 0.038 mol·kg-1. The detection limit of the photoacoustic sensor is a gaseous ethanol pressure of 10-3 kPa. Ethanol molality changes as low as 0.001 mol·kg-1 can be measured.
http://www.gapoptic.unige.ch/Publications/Pdf/Sensor2.pdf

Determination of Nitroaromatic, Nitramine, and Nitrate Ester Explosives in Soil by Gas Chromatography and an Electron Capture Detector
Walsh, Marianne E., U.S. Army Cold Regions Research and Engineering Lab., Hanover, NH. Talanta, Vol 54 No 3, p 427-438, 2001

Traces of nitroaromatic, nitramine, and nitrate ester explosives in soil are traditionally determined by high-performance liquid chromatography (HPLC); however, commercially available deactivated injection port liners and wide-bore capillary columns have made routine analysis by gas chromatography (GC) possible. The electron-withdrawing nitro group common to each of these explosives makes the electron capture detector (ECD) suitable for determination of low concentrations of explosives in soil, water, and air. GC-ECD and HPLC-UV concentration estimates of explosives residues in field-contaminated soils from hazardous waste sites were compared, and correlation (r>0.97) was excellent between the two methods of analysis for each of the compounds most frequently detected: TNT, RDX), 2,4-DNT, 1,3-DNB, TNB, and HMX. Analytes most frequently found in soils collected near buried land mines were the microbial transformation products of TNT, manufacturing impurities of TNT, and TNT. The microbial reduction products of the isomers of DNT and of 1,3-DNB were also detected, but the ECD response to these compounds is poor.

Development of DNA Microarray Technology for Environmental Applications
Musarrat, Javed; Craig S. Criddle; Syed A. Hashsham. WEFTEC 2001: 74th Annual Water Environment Federation Conference and Exposition, Atlanta, Georgia, 13-17 October 2001. Water Environment Federation, Alexandria, VA. 17 pp, 2001

This study addresses two key issues related to the use of microarray technology in mixed microbial systems: signal strength and specificity. A glass-based small DNA microarray was robotically printed using 17 full-length and 50 partial gene probes (80-120 bp long) of the pdt locus involved in encoding pyridine 2,6-bis-thiocarboxylate (PDTC), a molecule implicated in the transformation of carbon tetrachloride by *Pseudomonas stutzeri* strain KC. This array was tested for signal strength and specificity using Cy5 and Cy3 labeled DNA from pure cultures of strain KC and mixed communities. For the selected set of genes, partial and full-length probes may be equally specific under environmental conditions; however, the former may require alternative strategies to increase sensitivity because of lower signal strength.

Diode-Based Integrated Circuits for Millimeter and Submillimeter-Wave Identification of Chemical and Biological Agents
Weikle, Robert M., II; T.W. Crowe, Virginia Univ., Charlottesville. School of Engineering and Applied Science. NTIS: ADA403400, 11 pp, Sep 2001

This final report summarizes efforts to realize a device and sensor technology for the study, detection, and identification of chemical and biological agents at millimeter and submillimeter-wave frequencies.

This effort has focused on two goals: the realization of an integrated-circuit technology for Terahertz Schottky diodes, and the development of sampled-line reflectometers for measuring the return loss (and consequently, absorption spectra) of chemical and bioagent samples. Schottky diodes represent the most successful device technology for applications in the submillimeter and terahertz region of the electromagnetic spectrum. Integrated planar diodes allow vast improvements in the level of performance of systems that rely on Schottky technology and permit the realization of fully integrated spectrometers and other instruments for chem/bio detection. During the past year and a half of this project, the researchers have developed a beamlead diode processing technology for producing planar chips that can be readily integrated into external circuitry. These discrete diodes will allow rapid prototyping of circuits and systems and permit higher levels of performance by eliminating many of the difficulties associated with manual assembly of hybrid components. Also, millimeter- and submillimeter-wave reflectometers have been developed based on the sampled-line architecture. These reflectometers can be used to measure the complex reflection coefficients (magnitude and phase) of various chemical and biological materials and utilize the planar Schottky device technology previously mentioned.
http://handle.dtic.mil/100.2/ADA403400

Distribution of Moisture Monitoring System for Landfill Covers, a Fiber-Optic Approach
Peace, Jerry, Sandia National Laboratories. Proceedings of the 13th Technology Information Exchange (TIE) Workshop, 12-15 November 2001, Sandia National Laboratories, Albuquerque, New Mexico [Abstracts]. TIE Quarterly, Vol 10 No 3, p 6, Winter 2002

Research is being performed to provide the Mixed Waste Landfill at Sandia National Laboratory with a landfill cover monitoring system. An essential component for long-term monitoring of landfill covers is the determination of the fluid flux or water balance through the cover. Research at Sandia is centering on a high spatial density system emplaced horizontally along cover layers as constructed. A distributed thermal optical fiber system is being coupled with the baseline neutron moisture logging system to create a robust and low cost moisture monitoring system. The optical fiber system for landfill monitoring consists of a continuous line of optical fiber and protective stainless steel tubing installed along horizontal layers in the landfill cover, plus a mobile monitoring system. As the water content of soil increases, so does the thermal conductivity. When constant power is dissipated from a line heat source—in this case, the electrical current through the stainless steel tubing—the temperature increase near the heat source will depend on the thermal conductivity of the material surrounding the heater. This method is similar to electrical thermistor-based methods. This continuous fiber optic system permits distributed moisture measurements compared to point measurements and provides a robustness and life-span similar ro buried fiber optic telecommunications systems.

DNAPL Characterization Methods and Approaches. Part I: Performance Comparisons
Kram, M.L. (Univ. of California, Santa Barbara), A.A Keller; J. Rossabi (Savannah River Technology Center, Aiken, SC); L.G. Everett (The IT Group, Santa Barbara, CA). Ground Water Monitoring and Remediation, Vol 21 No 1, p 67-76, 2001

This paper compares the advantages and disadvantages of many of the methods currently employed for detecting and delineating DNAPL contaminant source zones. Site characteristics, method performance, and method costs must all be considered to determine the most useful method for a particular site. DNAPL characterization methods are grouped into approaches, i.e., site preparation, characterization, and data processing activities necessary to design an effective remediation system. The authors compare the different approaches based on the level of chemical and hydrogeologic resolution, and the need for additional data requirements.
http://www.esm.ucsb.edu/fac_staff/fac/keller/default.html#Publications

DNAPL Characterization Methods and Approaches. Part II: Cost Comparisons
Kram, M.L. (Univ. of California, Santa Barbara), A.A Keller; J. Rossabi (Savannah River Technology Center, Aiken, SC); L.G. Everett (The IT Group, Santa Barbara, CA). Ground Water Monitoring and Remediation, Vol 22 No 1, 2002

This study compares the costs for implementing various characterization approaches using synthetic Unit Model Scenarios (UMSs), each with particular physical characteristics. Unit costs and assumptions related to labor, equipment, and consumables are applied to determine costs associated with each approach for various UMSs. In general, the direct-push sensor systems provide cost-effective characterization information in soils that are penetrable with relatively shallow (less than 10 to 15m) water tables. For sites with impenetrable lithology using direct-push techniques, the Ribbon NAPL Sampler Flexible Liner Underground Technologies (FLUTe™) membrane appears to be the most cost-effective approach. For all scenarios studied, Partitioning Interwell Tracer Tests (PITTs) are the most expensive approach due to the extensive pre- and post-PITT requirements. However, the PITT is capable of providing useful additional information, such as approximate DNAPL saturation, not generally available from any of the other approaches included in this comparison.
http://www.esm.ucsb.edu/fac_staff/fac/keller/default.html#Publications

DNAPL Site Characterization: a Comparison of Field Techniques
Griffin, Terry W.; Kenneth W. Watson (HSW Engineering, Inc.). Ground Water Monitoring & Remediation, Vol 22 No 2, Spring 2002

At a site where indirect and limited direct evidence of DNAPL exists, different approaches to DNAPL characterization were evaluated: a three-dimensional (3-D) high resolution seismic survey, field screening of soil cores with a flame ionization detector (FID)/ organic vapor analyzer (OVA), hydrophobic dye (Sudan IV)-impregnated reactive Flexible Liner Underground Technologies (FLUTe™) membrane used in combination with Rotasonic drill cores, centrifuged soil with Sudan IV dye, ultraviolet light (UV) fluorescence, a Geoprobe® Membrane Interface Probe (MIP™), and phase equilibrium partitioning evaluations based on laboratory analysis of soil samples. Sonic drilling provided continuous cores from which minor soil structures could be evaluated and the OVA provided reliable preliminary data for identifying likely DNAPL zones within the cores. The FLUTe™ membrane showed direct evidence for the presence of DNAPL. The MIP™ probe allowed rapid identification of probable DNAPL areas as well as soil conductivity data . The 3-D seismic survey was of minimal benefit to this study, and the centrifuging of samples with Sudan IV dye and the use of UV fluorescence provided no benefit. Results of phase equilibrium partitioning calculations to infer the presence of DNAPL agreed well with the site screening data.

Donnan Dialysis of Copper, Gold and Silver Cyanides with Various Anion Exchange Membranes [Footnote]
Akretchea, Djamal-Eddine; Hacene Kerdjoudj, Univ. of Science and Technology, 'Houari Boumediene', El-Alia, Algiers, Algeria. Talanta, Vol 51 No 2, p 281-289, 2000

Donnan dialysis is an ion exchange membrane process that can be used for the purification and concentration of diluted solutions. This paper examines the behavior of gold, silver, and copper in a cyanide medium. Flux of cyanide complexes and corresponding free cyanide were determined using five commercial anion exchanger membranes (AMV, ACS, RAI 5035, ADP, and ADS). The results show that the rate transfer depends upon the nature of the anion exchanger membrane. The species number in the feed solution influences the transfer selectivity of metal ion complex against free cyanide; e.g., gold that forms only one stable species with cyanides is transferred faster through an ACS membrane than copper, which forms three species. But this result is not verified when an ADS membrane is used. As indicated by a model of the complex transfer through anion exchange membranes based on Donnan dialysis, Donnan dialysis can be an efficient technique for the separation of cyanide complexes of copper, gold, and silver when parameters such as anion exchange membrane and the number of compartments are optimized. Also, the reactants can be recycled.

Donnan Dialysis Preconcentration Coupled with Ion Chromatography and Electrocatalytic Oxidation for the Determination of Cyanide
Seneviratne, Janaki; Scott D. Holmstrom; James A. Coxa, Miami Univ., Oxford, OH. Talanta, Vol 52 No 6, p 1025-1031, 2000

This paper describes an electrocatalytic amperometric detector for the ion chromatographic determination of cyanide based on a graphite-loaded sol-gel material that comprises the working electrode. The composite is doped with a RuII metallodendrimer that promotes the electrochemical oxidation of CN- at potentials positive of 0.5 V vs. Ag/AgCl.

Down in the Dumps: Landfill Characterization with an Extremely Fast IP Method
Zonge Engineering. Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 15 March 1999, Oakland, California. Workshop Notes. 1999

Zonge Engineering describes the demonstration of a multi-electrode DC/IP system that was fast and effective at locating trash pockets under a soil cap 17 feet thick.

Dynamic Workplans and Field Analytics: Metals Assessment by Inductively Coupled Plasma Optical Emission Spectroscopy
Simpson, R.L., III; C.L. Bock; A. Robbat, Jr. Remediation, Vol 9 No 4, p 65-78, 1999

Hazardous waste site investigations were carried out at the Marine Corps Air Station (MCAS) in Yuma, AZ, and at Hanscom Air Force Base (HAFB) in Bedford, MA. At MCAS, the location and extent of metals contamination throughout the base was determined. At HAFB, the investigation evaluated the risk of metals contamination to ground water from soil at three locations within the airfield. Dynamic workplans were developed and an adaptive sampling and analysis plan carried out with the data produced in the field used to support the goals of each project. An inductively coupled plasma/optical emission spectrometer (ICP/OES) was modified for field operation. A more efficient microwave digestion method and pressurized Teflon filtration system were developed for the HAFB project. Results were comparable to standard EPA methods. The MCAS investigation, conducted over a five-month period, advanced the Navy's efforts from 30 months behind schedule to 18 months ahead of schedule, while the data generated at HAFB showed no risk to ground water from metals.

Ecotoxicity Monitoring of Hydrocarbon-Contaminated Soil Using Earthworm (*Eisenia foetida*)
Shin, Kyung-Hee; Kyoung-Woong Kim, Advanced Environmental Monitoring Research Center (ADEMRC), Kwangju Inst. of Science and Technology, Kwangju, Republic of Korea. Environmental Monitoring and Assessment, Vol 70 No 1-2, p 93-103, Jul 2001

The applicability of an earthworm bioassay as a technique for monitoring the soil flushing process was examined in short-term and long-term toxicity tests conducted on remediated soil using various pore volumes of surfactant solution. Results obtained on short-term toxicity testing indicated that biomass increased as the soil flushing proceeded, and on diesel-contaminated soils this testing showed that the effect of diesel is lethal and that 25 pore volumes of soil surfactant were not sufficient to abrogate the toxic effect of diesel. These short-term tests also showed strong sublethal relationships between the development of biomass and the concentrations of toxic chemicals in the soil. Although relationships between contaminants and the various bioassay parameters examined were not significant in long-term testing, an increase in the number of juveniles was observed over time, which may have been a consequence of a reduction in toxicity associated with the flushing process.

The Effect of Functional Group Structure on the Elution of Metal Cyanide Complexes from Ion-Exchange Resins

Lukey, G.C.; J.S.J. Van Deventer; D.C. Shallcross, Dept. of Chemical Engineering, Univ. of Melbourne, Melbourne, Vic., Australia. Separation Science and Technology, Vol 35 No 15, p 2393-2413, 2000

The authors investigated the elution properties of five experimental resins that have the same type of resin matrix but contain different aliphatic amino functional groups. Ammonium thiocyanate proved to be not a suitable eluant because iron and zinc are not completely eluted from any of the resins studied. Potassium thiocyanate at a pH greater than 12 can be used to recover more than 80% of copper, zinc, and iron within the first 10 bed volumes of eluant for most resins. The recovery of gold from each resin using potassium thiocyanate was considerably slower than that of other metals, with ~60% recovered after 20 bed volumes of eluant. The length of the alkyl chain of the functional group did not affect significantly the elution of metal cyanide complexes from the resins studied using the thiocyanate eluant. The elution of metals from all resins was found to be superior when using a 0.5 M zinc cyanide eluant at a temperature of 50 degrees C. More than 90% of copper, silver, and iron were recovered from most resins within four bed volumes of eluant. The recovery of gold using a zinc cyanide eluant depends upon the ionic density of the resin and also the stereochemistry of the attached functional group. The results of this study show that zinc cyanide is not a suitable eluant for gold-selective ion-exchange resins.

Electrical and EM Methods Applied to Engineering and Environmental Problems

Lee, Ki Ha, Lawrence Berkeley National Laboratory. The 3rd International Symposium on Recent Advances in Exploration Geophysics in Kyoto (RAEG '98)

Electrical conductivity and permittivity (dielectric constant), which are sensitive to the chemical and hydrological state of the subsurface, can be applied to characterizing landfills, buried waste pits, and trenches; delineating contaminant plumes; verifying and monitoring an engineered subsurface barrier; monitoring grout injection for stabilization and containment; and locating contaminant sources such as non-aqueous phase liquids (NAPL). Electrical and electromagnetic (EM) methods have been used to map subsurface electrical conductivity distribution for exploration of mineral resources, ground water, and ground-water contamination, and general study in earth crust. Electrical methods have been applied to map resistivity (inverse of conductivity) distribution, which in turn has been used to estimate water saturation and to delineate subsurface geology. Along with the resistivity method, induced polarization (IP) has become an important tool in investigating subsurface phenomena involving various chemical contaminants and minerals often associated with clay. Recent development in high-frequency controlled-source magnetotelluric (CSMT) methods allows investigation of near-surface electrical conductivity distribution with improved resolution. Ground penetrating radar (GPR) can map subsurface structures in great detail when conditions are right. To successfully obtain high-resolution images of the shallow subsurface, including the determination of various buried waste forms, and the monitoring and verification applications, wide-band, densely sampled data is essential. In many cases, there is a gap in the detection and resolving capability between the lower limit of GPR and the upper limit of traditional EM. Bridging this gap is essential to characterizing buried waste, detecting contaminant plumes, monitoring and verifying remediation activities, and imaging other environmental and engineering targets located in the shallow subsurface. Researchers have been investigating a frequency band between traditional EM and GPR -- 100 kHz to 50 MHz. The method of analysis is the EM impedance approach requiring the ratio of electric to magnetic fields. A capacitive electric field measurement technique is being investigated to further develop borehole resistivity methods. Most drill holes for engineering and hydrologic study are cased with plastic, so traditional galvanic measurement using grounded electrodes is not possible. The success of the approach depends on finding the range of frequencies high enough to yield electric fields capacitively, but low enough to yield negligible EM induction.

Electrochemical DNA Biosensor as a Screening Tool for the Detection of Toxicants in Water and Wastewater Samples
Lucarelli, F. (Univ. á degli studi di Firenze, Firenze , Italy), I. Palchetti, G. Marrazza, M. Mascini.
Talanta, Vol 56 No 5, p 949-957, 2002

This paper reports recent applications of a disposable electrochemical DNA biosensor to standard solutions and to real samples. The DNA biosensor is assembled by immobilizing the double-stranded calf thymus DNA on the surface of a disposable carbon screen-printed electrode. The immobilized ds-DNA interacts with the sample for 2 minutes, then is washed and immersed in a clean buffer where the analytical signal (the oxidation peak area of the guanine base) is obtained by a square-wave voltammetric scan.

Electromagnetic Radiography for Subsurface Characterization of Contaminated Soils
Finci, Aka G., Detection Sciences, Inc. Thirteenth Technical Information Exchange Workshop, 12-15 November 2001, Sandia National Laboratories, Albuquerque, New Mexico [Abstracts]. TIE Quarterly, Vol 10 No 3, p 53, Winter 2002

Electromagnetic Radiography (EMR) has been used at a couple of DOE sites to provide images of mercury and other contaminants in the low ppm range. This high-speed, relatively low-cost process provides 100% coverage down to 50 feet. Disadvantages of the system are that it can't detect at the low concentrations (ppb) present at most sites, it's not effective when salt water is present, and it gives broad classification of contaminants only, such as dense non-aqueous phase liquids (DNAPL), but not individual contaminants. It may be an effective screening tool for some contaminants. The system is undergoing further development to enhance its capabilities.

Electromagnetic Surveys for 3-D Imaging of Subsurface Contaminants. Cost and Performance Report
GEHM Environmental Corporation and Center for Environmental Technology , Univ. of Missouri.
Report No: NFESC TR-2124-ENV, 77 pp, Nov 2000

This report discusses a demonstration performed by GEHM Environmental Corporation and the Center for Environmental Technology at the University of Missouri (Columbia). The project investigated the use of quasi-static electromagnetic (EM) resistivity surveys to detect dense non-aqueous phase liquid (DNAPL) contamination in the subsurface at two U.S. DoD installations. The EM resistivity survey technique is a surface-to-borehole geophysical method that generates a three-dimensional (3-D) image of subsurface features based on their contrasting resistive properties. The two sites selected for the study were the former Naval Air Station Alameda and Tinker Air Force Base. The primary objective of the investigation was to verify that the EM technique could consistently, rapidly, and accurately perform high resolution site characterization and DNAPL source delineation. The results from the two study sites indicate that EM survey techniques do not adequately predict where significant subsurface DNAPL

is located. The estimated survey costs to perform an EM resistivity survey over one acre at Alameda Point and Tinker AFB were $154,209 and $134,262, respectively.
http://www.estcp.org/documents/techdocs/index.cfm

Environmental Impact Assessment of the Mining and Concentration Activities in the Kola Peninsula, Russia by Multidate Remote Sensing
Olga Rigina, Olga, Inst. of Geography, Univ. of Copenhagen, Copenhagen K., Denmark.
Environmental Monitoring and Assessment, Vol 75 No 1, p 13-33, Apr 2002

On the Kola Peninsula, mine tailing dumps pollute the air through dusting, and water is affected by direct dumping and accidental releases. This paper describes a project to analyze multidate satellite images for 1964-1996 to assess the environmental pollution from the mining and concentration activity in the Kola in temporal perspective, and to evaluate remote sensing methods for integrated environmental impact assessment. For effective assessment of impacts from the mining and concentration industry, remote sensing methods should be complemented by in situ measurements, field work, and mathematical modeling.

ESA's Harsh Environments InitiativeSpace Sensors for Ground Applications
Brisson, P.; J. Grabenhofer, ESA/ESTEC, The Netherlands. European Geophysical Society (EGS) XXVI General Assembly, 25-30 March 2001, Nice, France. Geophysical Research Abstracts, Volume 3, 2001. CD-ROM

In 1997, ESA initiated the HEI to demonstrate that the transfer of European and Canadian space technologies can bring substantial benefits to industries operating in harsh environments. An example project is the Remote Monitoring Station (REMOST) to determine contamination of water bodies. Other technologies under development include optical sensors for biological fluids, an artificial nose (array), a paramagnetic oxygen sensor, an alpha-Proton-X-Ray spectrometer, and a Mossbauer spectrometer.

An Evaluation of Field Total Petroleum Hydrocarbon (TPH) Systems
Lambert, P. (Environment Canada, Ottawa, Ont., Canada), M. Fingas; M. Goldthorp (Goldthorp Consulting, Kemptville, Ont., Canada). Journal of Hazardous Materials, Vol 83 No 1-2, p 65-81, 2001

This paper describes the results of an evaluation of several field kits and petroleum hydrocarbon measuring systems: the immunoassay-based EnviroGard petroleum fuels in soil test kit (EnviroGard, Millipore Canada, Mississauga, Ont.), the turbidimetric based PetroFlag hydrocarbon test kit for soil (Dexsil, Hamden, CT), a DR/2000 field kit (Hach Company, Loveland CO) employing colorimetric test procedures and a total organic carbon (TOC) analysis instrument (Dohrmann Division, Rosemount Analytical Inc., Santa Clara, CA) using oxidation principles. The kits and systems were compared to the traditional technique of extracting the petroleum hydrocarbons using trichlorotrifluoroethane (Freon 113) as the solvent and subsequent infrared (IR) analysis with a portable fixed wavelength analyzer (Buck Scientific, East Norwalk, CT).

Evaluation of Immobilized Redox Indicators as Reversible, In Situ Redox Sensors for Determining Fe(III)-Reducing Conditions in Environmental Samples
Jones, B.D.; J.D. Ingle, Oregon State Univ., Corvallis. Talanta, Vol 55 No 4, p 699-714, 2001

This paper describes an in situ methodology based on immobilized redox indicators (thionine, toluidine blue O, and cresyl violet) to determine when Fe(III)-reducing conditions exist in environmental systems.

Evaluation of Isotopic Diagnostics for Subsurface Characterization and Monitoring: Field Experiments at the TAN and RWMC (SDA) Sites, INEEL
DePaolo, Donald J. (E.O. Lawrence Berkeley National Lab.), Mark E. Conrad, and B. Mack Kennedy; Eric C. Miller (Idaho National Engineering and Environmental Lab.), Erick R. Neher, and Thomas R. Wood; P. Evan Dresel)Pacific Northwest National Lab.) and John Evans. U.S. DOE Project Number: 55351, Final Project Report. 29 pp, 2000

The results of studies of a plume of mixed wastes containing low-level radionuclides, sewage, and chlorinated solvents at DOE's Idaho National Engineering and Environmental Laboratory (INEEL) demonstrate how isotopic measurements can be used to help answer questions of critical importance for environmental management. The researchers reached the following conclusions: 1) natural biodegradation of chlorinated solvents can be documented by carbon isotope ratios; 2) engineered biodegradation can be verified by measurements of natural isotopic tracers; and 3) natural isotopic tracers can be used in lieu of injection experiments to characterize ground-water systems. The studies have produced important field data about basic scientific processes, such as the infiltration of water through the unsaturated zone and the potential for subsurface biologic activity in arid environments.
http://www.osti.gov/em52/final_reports/55351.pdf

Experimental Investigations on the Properties of DNAPLs Migration
Endo, Kazuto (Kyoto Univ., Japan); Takeshi Katsumi (Ritsumeikan Univ., Japan); Masashi Kamon (Kyoto Univ., Japan). Third BGA Geoenvironmental Engineering Conference, 17-19 September 2001, Edinburgh, Scotland, UK

DNAPLs migration properties can be represented using the k-S-p relations, which stands for relative permeability, degree of saturation, and matric potential. The authors developed an experimental method to clarify the k-S-p relations using a column test that uses tensiometer probes for measuring resistance and matric potential of water and DNAPLs. The probe for measuring resistance resembles the miniature resistivity probe. Developing a method for measuring resistance uses three needle-like electrodes of length, 1.5 cm. Sodium chloride of known concentration was used. There is an advantage to measuring many points in a simple cheap way, when they can be made by hand. To obtain the properties of soil moisture, a hydrophilic tensiometer can be used for measuring the matric potential of water in unsaturated condition; however, the tensiometer developed in this research is an oil tensiometer (hydrophobic) that measures the matric potential of NAPLs in the soil system. It can be made up by saturating the ceramic cup of the hydrophobic tensiometer with DNAPLs. If the geotechnical constants do not change, k-S-p relations can vary depending on the surface tension, density and viscosity of DNAPLs. The aim of this research is to clarify the details of DNAPLs behavior based on its three parameters, and then obtain k-S-p relations with the availability of any kind of DNAPLs.

Exploration and Detection of Subsurface Water Using Broadband Electromagnetic Sensors
McGlone, T. David. Environmental Geosciences, Vol 5 No 4, p 187-195, Dec 1998

The use of wide bandwidth receivers in electromagnetic geophysical surveys can provide information that limited bandwidth instruments can not. A magnetic field receiver with a small physical size allows array measurements of electromagnetic fields in a manner similar to arrays used for seismic measurements, which makes feasible 2-D and 3-D electromagnetic imaging. The wide bandwidth of the receiver also allows time and frequency domain measurements to be made simultaneously. A wide bandwidth, vector-field sensitive receiver has been developed and field-tested for functionality in geophysical applications. The availability of such a receiver allows the possibility of not only detecting a conductivity anomaly such as subsurface water flow but the possible identification of contaminants within the water as well.

Explosives Detection in Soil Using a Field-Portable Continuous Flow Immunosensor
Gauger, P.R. (GEO-Centers Inc., Rockville, MD); D.B. Holt (Naval Research Laboratory, Washington, DC), C.H. Patterson Jr., P.T. Charles, L. Shriver-Lake, A.W. Kusterbeck. Journal of Hazardous Materials, Vol 83 No 1-2, p 51-63, 2001

A field method for quantitative analysis of explosives in contaminated soil samples is based on a displacement immunoassay performed in a commercial instrument, the FAST 2000, engineered by Research International, Inc. The method can be used on-site to measure TNT and RDX within five minutes. In the method's development, replicate analyses were performed on soil extracts prepared from each field sample as well as appropriate controls, blanks, and laboratory standards. Statistical analyses assessed accuracy, bias, and predictability of the method. The results demonstrated that the immunosensor could be used effectively to screen environmental samples for the presence or absence of explosives.

Fast and Highly Selective Determination of Cyanide with 2,2-Dihydroxy-1,3-Indanedione [Short communication]
Drochioiu, G., Al. I. Cuza' Univ. of Iasi, Iasi, Romania. Talanta, Vol 56 No 6, p 1163-1165, 2002

The author proposes a simple, accurate, fast, selective, and sensitive assay of cyanide based on its reaction with 2,2-dihydroxy-l,3-indanedione at basic pH. As little as 0.01 µg ml-1 of cyanide can be determined. One ml of sample solution is mixed with 500 µl of 5 mg ml-1 solution of 2,2-dihydroxy-1,3-indanedione monohydrate in 2% sodium carbonate. The absorbance of the purple color is measured at 510 nm in 1-cm glass cuvettes, 10-15 min after mixing the reagents. The procedure could also be used to identify free CN- in natural waters and hydrocyanic acid in the environment.

Fast Determination of Lead in Lake Sediment Samples Using Electrothermal Atomic Absorption Spectrometry with Slurry Samples Introduction
Baralkiewicz, Danuta, Adam Mickiewicz Univ., Drzmaly, Pozna, Poland. Talanta, Vol 56 No 1, p 105-114, 2002

Lead concentration in lake sediment samples has been determined by means of ultrasonic slurry sampling electrothermal atomic absorption spectrometry (USSS-ETAAS). The soil samples were suspended in four different nitric acid solutions, and the effects of the instrumental operating conditions and slurry preparation on the signal were examined. Palladium and magnesium were used as modifiers to improve the signal quality. The procedure was validated by analysis of certified reference lake sediment material. All analytical recoveries for lead in slurried lake sediment samples were satisfactory and varied from 95 to 104%. Relative standard deviation values were 4.8, 4.7, 4.5, and 5.5. The detection limits LODs of lead were 0.52, 0.45, 0.35, and 0.22 µg g-1 for mass of sample 0.025, 0.050, 0.10 and 0.15 U, respectively.

Fiber Optic/Cone Penetrometer System for Subsurface Heavy Metals Detection. Innovative Technology Summary
U.S. DOE, Subsurface Contaminants Focus Area and Industry Programs. Report No: DOE/EM-0508, 25 pp, Mar 2000

An integrated laser induced breakdown spectroscopy (LIBS) and cone penetrometer technology (CPT) system has been developed to analyze the heavy-metals content of subsurface soils in situ and with rapid results, currently less than 24 hours. The CPT/LIBS system for subsurface heavy metals detection was successfully demonstrated at the Chemical Waste Landfill at Sandia National Labs outside of Albuquerque, NM. The demonstration of the CPT/LIBS system focused on measurement of chromium as a function of depth. The results correlated well with data collected from past soil borings installed in the test location. Science and Engineering Associates, Inc., also successfully field tested two stand-alone LIBS instruments developed by Los Alamos National Laboratories: a backpack-mounted system for in situ analysis of surficial soils and a van-housed system for field analysis of ex situ soil samples. This field test was conducted at a Formerly Utilized Sites Remedial Action Program site in Luckey, Ohio, to evaluate the beryllium concentration in surficial soils.
http://apps.em.doe.gov/ost/itsrscfa.html

Field and Laboratory Evaluations of a Real-Time PAH Analyzer. Project Summary
Ramamurthi, Mukund; Jane C. Chuang. Report No: EPA/600/SR-97/034, 3 pp, Jul 1997

This study continued a previous evaluation of a real-time analyzer for polycyclic aromatic hydrocarbons (PAHs) in air. The responses of the instruments, Gossen PAS Models 1000i and 1002i, were evaluated for vapor-phase versus particle-phase PAH, and for variations in the environmental conditions of temperature and humidity. A cigarette smoke generator was developed for use in field evaluations of the analyzer. The particle transmission efficiency was also measured for a range of particle sizes below 1 mm. In general, the PAS responded only to PAH in the particulate phase. Small responses to vapor-phase PAH in two experiments were found to be associated with adsorption of the test PAH on particle surfaces. Small and insignificant ozone levels were measured within a few inches of the instrument. Its noise output was below the NC-35 criterion, except in the frequency range 1000 to 3000 Hz, where the noise approached NC-40. Temperature and humidity did not affect the response of the PAS to aerosols that were equilibrated at the test temperature. The particle transmission efficiency through the PAS was determined for a range of aerosols 0.034 to 0.32 mm. Large particle losses below 0.10 mm were identified. A modified sampling configuration was developed, which increased the particle transmission efficiency to greater than 90% over the entire size spectrum, without having deleterious effects on the performance of the analyzer.

Field Applications of Complex Resistivity Tomography
Kemna, Andreas (DMTGeoTec Division, Essen, Germany), Eiko Rakers; Lothar Dresen (Bochum Univ., Bochum, Germany). Society of Exploration Geophysicists (SEG) 1999 Expanded Abstracts

This paper presents a complex resistivity inversion algorithm and its application to field data from different tomographic surveys. The algorithm is based on the finite-element method for forward modeling and a regularized Gauss-Newton approach to solve the inverse problem, with both parts being formulated in terms of complex arithmetic. In the first field data example, the inversion procedure is successfully applied to delineate subsurface hydrocarbon contamination at a former jet fuel depot. A Cole-Cole analysis of the inversion results at multiple frequencies provides additional structural information. The second example is from a mineral exploration survey and indicates a zone of high sulfide concentration within a metamorphic rock complex. The examples demonstrate the usefulness of complex resistivity tomography for both environmental and mining-related field problems.
http://www.seg.org/meetings/past/seg1999/techprog/detail/EM3.html

Field Gas Chromatography/Thermionic Detector System for On-Site Determination of Explosives in Soils

Hewitt, Alan D.; T.F. Jenkins; T.A. Ranney, Cold Regions Research And Engineering Lab., Hanover, NH. Report Number: ERDC/CRREL-TR-01-9; NTIS: ADA390773. 29 pp, May 2001

On-site determination of nitroaromatic, nitramine, and nitrate ester explosives compounds in soils was performed using a field-portable gas chromatograph (GC) equipped with a thermionic ionization detector (TID) selective for compounds with nitro functional groups. Soil samples were extracted with acetone. A one-microliter volume of the filtered soil extract was manually injected into the GC, allowing for the rapid qualification and quantification of the suite of explosives that often coexist in soils at military training facilities and other defense-related sites. Good agreement was established for the concentrations of several explosives analytes when this method of analysis was compared to either high-performance liquid chromatography (Method 8330) or GC electron capture (Method 8095) analysis. Comparisons were performed for sample extracts and for soil sub-sample replicates distributed for on-site preparation and analysis during a field verification test performed under the auspices of the U.S. EPA's Environmental Technology Verification (ETV) Program.
http://handle.dtic.mil/100.2/ADA390773

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil: CHEMetrics, Inc., and AZUR Environmental Ltd RemediAid™ Total Petroleum Hydrocarbon Starter Kit. Innovative Technology Verification Report
Tetra Tech EM Inc., Chicago, IL. Report No: EPA/600/R-01/082, 123 pp, Sep 2001

The RemediAid™ Total Petroleum Hydrocarbon Starter Kit developed by CHEMetrics, Inc., and AZUR Environmental Ltd. was demonstrated under EPA's Superfund Innovative Technology Evaluation Program in June 2000 at the Navy Base Ventura County site in Port Hueneme, CA. The demonstration collected performance and cost data for the RemediAid™ kit and six other field measurement devices for total petroleum hydrocarbons (TPH) in soil. In addition to assessing ease of device operation, the key objectives of the demonstration included determining the method detection limit, accuracy and precision, effects of interferents and soil moisture content on TPH measurement, sample throughput, and TPH measurement costs for each device. The demonstration involved analysis of both performance evaluation samples and environmental samples collected in five areas contaminated with gasoline, diesel, lubricating oil, or other petroleum products. The performance and cost results for a given field measurement device were compared to those for an off-site laboratory reference method, SW-846 Method 8015B (modified). During the demonstration, CHEMetrics required 46 hours, 10 minutes, for TPH measurement of 199 samples and 10 extract duplicates. The TPH measurement costs for these samples were estimated to be $8,510 for the RemediAid™ kit and $42,170 for the reference method. The method detection limits were determined to be 60 and 4.79 milligrams per kilogram for the RemediAid™ kit and reference method, respectively. During the demonstration, the RemediAid™ kit exhibited good accuracy and precision, ease of use, and lack of sensitivity to interferents that are not petroleum hydrocarbons (neat materials, including PCE and 1,2,4-trichlorobenzene). However, the device showed less than 5% response to neat materials, including MTBE and Stoddard solvent, that are petroleum hydrocarbons. Turpentine and humic acid, which are not petroleum hydrocarbons, caused a significant measurement bias for the device. In addition, the device exhibited minor sensitivity to soil moisture content during TPH measurement of weathered gasoline soil samples. Despite some of the limitations observed during the demonstration, the demonstration findings collectively indicated that the RemediAid™ kit is a reliable field measurement device for TPH in soil.
http://www.epa.gov/ORD/SITE/reports/EPA600R-01082.htm

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil: Dexsil® Corporation PetroFLAG™ System. Innovative Technology Verification Report
Tetra Tech EM Inc., Chicago, IL. Report No: EPA/600/R-01/092, 125 pp, Sep 2001

The PetroFLAG™ System developed by Dexsil® Corporation was demonstrated under EPA's Superfund Innovative Technology Evaluation Program in June 2000 at the Navy Base Ventura County site in Port Hueneme, CA. The demonstration collected performance and cost data for the PetroFLAG™ System and six other field measurement devices for total petroleum hydrocarbons (TPH) in soil. In addition to assessing ease of device operation, the key objectives of the demonstration included determining the method detection limit, accuracy and precision, effects of interferents and soil moisture content on TPH measurement, sample throughput, and TPH measurement costs for each device. The demonstration involved analysis of both performance evaluation (PE) samples and environmental samples collected in four areas contaminated with gasoline, diesel, or other petroleum products. The performance and cost results for a given field measurement device were compared to those for an off-site laboratory reference method, SW-846 Method 8015B (modified). During the demonstration, Dexsil required 50 hours, 40 minutes, for TPH measurement of 181 samples and 10 extract duplicates. The TPH measurement costs for these samples were estimated to be $6,390 for the PetroFLAG™ System compared to $38,560 for the reference method. The method detection limits were determined to be 20 and 6.32 milligrams per kilogram for the PetroFLAG™ System and reference method, respectively. During the demonstration, the PetroFLAG™ System exhibited good precision and ease of use. The device's mean responses for interferents that are considered to be petroleum hydrocarbons were mixed (0 and 42.5% for neat MTBE and Stoddard solvent, respectively). The device's mean responses for interferents that are not considered to be petroleum hydrocarbons were also mixed (1.5, 103, and 16% for neat PCE, turpentine, and 1,2,4-trichlorobenzene, respectively, and 2.5% for soil spiked with humic acid). In addition, an increase in soil moisture content biased the device's TPH results low for weathered gasoline soil PE samples. Based on action level conclusions and statistical correlations, the PetroFLAG™ System TPH results compared well with those of the reference method; however, the device exhibited a high bias, and its TPH results were determined to be statistically different from those of the reference method. Collectively, the demonstration findings indicated that the user should exercise caution when considering the device for a specific field TPH measurement application.
http://www.epa.gov/ORD/SITE/reports/EPA600R-01092.htm

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil: Environmental Systems Corporation Synchronous Scanning Luminoscope. Innovative Technology Verification Report
Tetra Tech EM Inc., Chicago, IL. Report No: EPA/600/R-01/083, 129 pp, Sep 2001

The Synchronous Scanning Luminoscope developed by Oak Ridge National Laboratory in collaboration with Environmental Systems Corporation (ESC) was demonstrated under EPA's Superfund Innovative Technology Evaluation Program in June 2000 at the Navy Base Ventura County site in Port Hueneme, California. The demonstration collected performance and cost data for the Luminoscope and six other field measurement devices for total petroleum hydrocarbons (TPH) in soil. In addition to assessing ease of device operation, the key objectives of the demonstration included determining the method detection limit, accuracy and precision, effects of interferents and soil moisture content on TPH measurement, sample throughput, and TPH measurement costs for each device. The demonstration involved analysis of both performance evaluation samples and environmental samples collected in five areas contaminated with gasoline, diesel, lubricating oil, or other petroleum products. The performance and cost results for a given field measurement device were compared to those for an off-site laboratory reference method, SW-846 Method 8015B (modified). During the demonstration, ESC required 67 hours, 30 minutes, for TPH measurement of 199 samples and 12 extract duplicates. The TPH measurement costs for these samples were estimated to be $7,460 for ESC's on-site sample analysis service option using the Luminoscope and $34,950 for the Luminoscope purchase option compared to $42,430 for the reference method. The method detection limits were determined to be 36 and 6.32 milligrams per kilogram for the Luminoscope and reference method, respectively. During the demonstration, the Luminoscope exhibited good precision and lack of sensitivity to moisture content and to interferents that are not petroleum

hydrocarbons (PCE, turpentine, and 1,2,4-trichlorobenzene); however, the Luminoscope TPH results did not compare well with those of the reference method, indicating that the user should exercise caution when considering the device for a specific field TPH measurement application. In addition, field observations indicated that operation of the device may prove challenging unless the operator has significant analytical chemistry skills and device-specific training.
http://www.epa.gov/ORD/SITE/reports/EPA600R-01083.htm

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil: Horiba Instruments Incorporated OCMA-350 Oil Content Analyzer. Innovative Technology Verification Report
Tetra Tech EM Inc., Chicago, IL. Report No: EPA/600/R-01/089, 123 pp, Sep 2001

The OCMA-350 Oil Content Analyzer developed by Horiba Instruments Inc. was demonstrated under EPA's Superfund Innovative Technology Evaluation Program in June 2000 at the Navy Base Ventura County site in Port Hueneme, CA. The demonstration collected reliable performance and cost data for the OCMA-350 and six other field measurement devices for total petroleum hydrocarbons (TPH) in soil. In addition to assessing ease of device operation, the key objectives of the demonstration included determining the method detection limit, accuracy and precision, effects of interferents and soil moisture content on TPH measurement, sample throughput, and TPH measurement costs for each device. The demonstration involved analysis of both performance evaluation samples and environmental samples collected in five areas contaminated with gasoline, diesel, lubricating oil, or other petroleum products. The performance and cost results for a given field measurement device were compared to those for an off-site laboratory reference method, SW-846 Method 8015B (modified). During the demonstration, Horiba required 46 hours, 15 minutes, for TPH measurement of 199 samples and 9 extract duplicates. The TPH measurement costs for these samples were estimated to be $15,750 for the OCMA-350 compared to $42,050 for the reference method. The method detection limits were determined to be 15.2 and 4.79 milligrams per kilogram for the OCMA-350 and reference method, respectively. During the demonstration, the OCMA-350 exhibited good precision and sensitivity to interferents that are petroleum hydrocarbons (MTBE and Stoddard solvent); however, the OCMA-350 TPH results did not compare well with the reference method results for the performance evaluation samples and were significantly impacted by soil moisture content and by turpentine, an interferent that is not a petroleum hydrocarbon. In addition, some of the items in the OCMA-350 made the TPH measurement procedure less simple and more time consuming during the demonstration. Collectively, the demonstration findings indicated that the OCMA-350 may be considered for TPH screening purposes; however, the user should exercise caution when considering the device for a field TPH measurement application requiring definitive results.
http://www.epa.gov/ORD/SITE/reports/EPA600R-01089.htm

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil: siteLAB® Corporation siteLAB® Analytical Test Kit UVF-3100A. Innovative Technology Verification Report
Tetra Tech EM Inc., Chicago, IL. Report No: EPA/600/R-01/080, 125 pp, Sep 2001

The siteLAB® Analytical Test Kit UVF-3100A developed by siteLAB® Corporation was demonstrated under EPA's Superfund Innovative Technology Evaluation (SITE) Program in June 2000 at the Navy Base Ventura County site in Port Hueneme, CA. The demonstration collected performance and cost data for the UVF-3100A and six other field measurement devices for total petroleum hydrocarbons (TPH) in soil. In addition to assessing ease of device operation, the key objectives of the demonstration included determining the method detection limit, accuracy and precision, effects of interferents and soil moisture content on TPH measurement, sample throughput, and TPH measurement costs for each device. The demonstration involved analysis of both performance evaluation samples and environmental samples collected in five areas contaminated with gasoline, diesel, lubricating oil, or other petroleum products.

The performance and cost results for a given field measurement device were compared to those for an off-site laboratory reference method, SW-846 Method 8015B (modified). During the demonstration, siteLAB® required 37 hours, 20 minutes, for TPH measurement of 199 samples and 13 extract duplicates. The TPH measurement costs were estimated to be $7,090 for siteLAB®'s UVF-3100A rental option; $7,720 for the UVF-3100A on-site testing support service option; and $17,670 for the UVF-3100A purchase option compared to $42,500 for the reference method. The method detection limits were determined to be 3.4 and 6.32 milligrams per kilogram for the UVF-3100A and reference method, respectively. During the demonstration, the UVF-3100A exhibited good accuracy and precision, ease of use, and lack of sensitivity to interferents that are not petroleum hydrocarbons (neat materials, including PCE, turpentine, and 1,2,4-trichlorobenzene and soil spiked with humic acid). However, the device showed less than 5% response to neat materials (MTBE and Stoddard solvent) that are petroleum hydrocarbons. In addition, it exhibited minor sensitivity to soil moisture content during TPH measurement of weathered gasoline soil samples. Despite some of the limitations observed during the demonstration, the demonstration findings collectively indicated that the UVF-3100A is a reliable field measurement device for TPH in soil.
http://www.epa.gov/ORD/SITE/reports/EPA600R-01080.htm

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil: Strategic Diagnostics Inc. EnSys Petro Test System. Innovative Technology Verification Report
Tetra Tech EM Inc., Chicago, IL. Report No: EPA/600/R-01/084, 119 pp, Sep 2001

The EnSys Petro Test System developed by Strategic Diagnostics Inc. (SDI) was demonstrated under EPA's Superfund Innovative Technology Evaluation Program in June 2000 at the Navy Base Ventura County site in Port Hueneme, CA. The demonstration collected performance and cost data for the EnSys Petro Test System and six other field measurement devices for total petroleum hydrocarbons (TPH) in soil. In addition to assessing ease of device operation, the key objectives of the demonstration included determining the method detection limit, accuracy and precision, effects of interferents and soil moisture content on TPH measurement, sample throughput, and TPH measurement costs for each device. The demonstration involved analysis of both performance evaluation samples and environmental samples collected in four areas contaminated with gasoline, diesel, or other petroleum products. The performance and cost results for a given field measurement device were compared to those for an off-site laboratory reference method, SW-846 Method 8015B (modified). During the demonstration, SDI required 39 hours, 35 minutes, for TPH measurement of 191 samples and 12 extract duplicates. The TPH measurement costs for these samples were estimated to be $10,210 for the EnSys Petro Test System compared to $41,290 for the reference method. The method detection limit for the reference method was determined to be 6.32 milligrams per kilogram; a method detection limit could not be determined for the EnSys Petro Test System because it is a semiquantitative device. During the demonstration, the device exhibited good precision and lack of sensitivity to soil spiked with humic acid. The device showed a mean response of at least 24% for interferents that are not petroleum hydrocarbons (neat materials, including PCE, turpentine, and 1,2,4-trichlorobenzene). A significant number of the EnSys Petro Test System TPH results were determined to be inconclusive because the detection levels used by SDI were not appropriate to address the demonstration objectives. Overall, the device's results did not compare well with those of the reference method; in general, the device exhibited a high positive bias. Collectively, the demonstration findings indicated that the user should exercise caution when considering the device for a site-specific field TPH measurement application.
http://www.epa.gov/ORD/SITE/reports/EPA600R-01084.htm

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil: Wilks Enterprise, Inc. Infracal TOG/TPH Analyzer. Innovative Technology Verification Report
Tetra Tech EM Inc., Chicago, IL. Report No: EPA/600/R-01/088, Sep 2001

The Infracal® TOG/TPH Analyzer developed by Wilks Enterprise, Inc., was demonstrated under EPA's Superfund Innovative Technology Evaluation Program in June 2000 at the Navy Base Ventura County site in Port Hueneme, CA. The demonstration collected performance and cost data for the Infracal® TOG/TPH Analyzer and six other field measurement devices for total petroleum hydrocarbons (TPH) in soil. In addition to assessing ease of device operation, the key objectives of the demonstration included determining the method detection limit, accuracy and precision, effects of interferents and soil moisture content on TPH measurement, sample throughput, and TPH measurement costs for each device. The demonstration involved analysis of both performance evaluation (PE) samples and environmental samples collected in five areas contaminated with gasoline, diesel, lubricating oil, or other petroleum products. The performance and cost results for a given field measurement device were compared to those for an off-site laboratory reference method, SW-846 Method 8015B (modified). During the demonstration, Wilks required 35 hours, 30 minutes, for TPH measurement of 215 samples. The TPH measurement costs for these samples were estimated to be $6,450 for the Infracal® TOG/TPH Analyzer compared to $44,410 for the reference method. The method detection limits were determined to be 76 and 4.79 milligrams per kilogram for the device and reference method, respectively. During the demonstration, the device exhibited sensitivity to interferents that are petroleum hydrocarbons (MTBE and Stoddard solvent) and lack of sensitivity to interferents that are not petroleum hydrocarbons (PCE, 1,2,4-trichlorobenzene, and humic acid). The device exhibited good precision for soil and liquid PE samples but not for environmental samples. The device TPH results did not compare well with the reference method results and were significantly impacted by soil moisture content (for diesel soil PE samples) and by turpentine, an interferent that is not a petroleum hydrocarbon. In addition, some of the items used during the sample preparation procedure made the TPH measurement procedure less simple and more time-consuming during the demonstration. Collectively, these demonstration findings indicated that the Infracal TOG/TPH Analyzer may be considered for TPH screening purposes; however, the user should exercise caution when considering the device for a field TPH measurement application requiring definitive results.
http://www.epa.gov/ORD/SITE/reports/EPA600R-01088.htm

Field Portable X-Ray Fluorescence Analyzer: Metorex X-MET 920-MP. Innovative Technology Verification Report
U.S. EPA, National Exposure Research Laboratory, Las Vegas, NV. Report No: EPA/600/R-97/151, 88 pp, Mar 1998

In April 1995, the U.S. EPA conducted a demonstration of field portable X-ray fluorescence (FPXRF) analyzers to determine how well FPXRF analyzers perform in comparison to standard reference methods, to identify the effects of sample matrix variations on the performance of FPXRF, to determine the logistical and economic resources needed to operate these analyzers, and to test and validate an SW-846 draft method for FPXRF analysis. The demonstration took place at the RV Hopkins site and the ASARCO Tacoma Smelter site. This demonstration found that the X-MET 920-MP Analyzer was generally simple to operate in the field; however, its physical configuration made it more practical for use as a benchtop unit. The auxiliary computer and cumbersome power requirements of commercial laptop computers limited its utility as an in situ instrument. The operator required no specialized experience or training for normal operation of the analyzer. Ownership and operation of this analyzer may require specific licensing by a state nuclear regulatory agency, and there are specific radiation safety training requirements and costs associated with this type of license. The Metorex X-MET 920-MP Analyzer can provide rapid, real-time analysis of the metals content of soil samples at hazardous waste sites. The analyzer can quickly identify contaminated areas from noncontaminated areas allowing investigation and remediation decisions to be made more efficiently on site and reduce the number of samples that need to be submitted for confirmatory analysis.
http://www.epa.gov/ORD/SITE/reports/600r97151.htm

Field Portable X-Ray Fluorescence Analyzers: Metorex X-MET 920-P and 940. Innovative Technology Verification Report
U.S. EPA, National Exposure Research Laboratory, Las Vegas, NV. Report No: EPA/600/R-97/146, 92 pp, Mar 1998

The U.S. EPA conducted a demonstration of field portable X-ray fluorescence (FPXRF) analyzers in April 1995 at the RV Hopkins site in Iowa and the ASARCO Tacoma Smelter in Washington. The primary objectives of the demonstration were to determine how well FPXRF analyzers perform in comparison to standard reference methods, to identify the effects of sample matrix variations on the performance of FPXRF, to determine the logistical and economic resources needed to operate these analyzers, and to test and validate an SW-846 draft method for FPXRF analysis. Two analyzers created by Metorex, the X-MET 920-P and 940, were used in this demonstration. The FPXRF analyzers were designed to provide rapid, real-time analysis of metals concentrations in soil samples. The X-MET 920-P and 940 analyzers provided definitive level data for copper, arsenic, lead, and zinc. This demonstration found that the X-MET 920-P and 940 analyzers were generally simple to operate in the field, and the operator required no specialized experience or training. Either analyzer can quickly distinguish contaminated areas from uncontaminated areas, allowing investigation and remediation decisions to be made more efficiently on site which may reduce the number of samples that need to be submitted for confirmatory analysis. The X-MET 920-P and 940 analyzers were found to be effective tools for field-based analysis of metals contamination in soil.
http://www.epa.gov/ORD/SITE/reports/142.htm

Field Portable X-Ray Fluorescence Analyzer: Niton XL Spectrum Analyzer. Innovative Technology Verification Report
U.S. EPA, National Exposure Research Laboratory, Las Vegas, NV. Report No: EPA/600/R-97/150, 93 pp, Mar 1998

In April 1995, the U.S. EPA conducted a demonstration of field portable X-ray fluorescence (FPXRF) analyzers to determine how well FPXRF analyzers perform in comparison to standard reference methods, to identify the effects of sample matrix variations on the performance of FPXRF, to determine the logistical and economic resources needed to operate these analyzers, and to test and validate an SW-846 draft method for FPXRF analysis. The demonstration took place at the RV Hopkins site and the ASARCO Tacoma Smelter site. No operational downtime was experienced by the Niton analyzer through the 20 days required to conduct this demonstration. Quantitative data were provided by the analyzer on a real-time basis. The XL Spectrum Analyzer was configured to report arsenic, chromium, copper, lead, and zinc. This analyzer used relatively short count times of 60 live-seconds for this demonstration. This relatively short count time resulted in a high sample throughput, averaging between 20 and 25 samples per hour. The XL Spectrum Analyzer provided definitive level data quality (equivalent to reference quality data) for lead, and quantitative screening level data quality (not equivalent to reference data but correctable with the analysis of confirmatory samples) for arsenic, copper, and zinc. No data quality assessment could be made for chromium since the short count time made the precision and method detection limit measurements problematic. This study showed that the Niton XL Spectrum Analyzer produced data that exhibit a log10 -log10 relationship with the reference data. The analyzer generally exhibited a lower precision compared to the reference methods. The XL Spectrum Analyzer precision RSD was generally between 6 and 14% at 5 to 10 times the method detection limit. The analyzer's quantitative results were based on a developer-set calibration using the Compton Ratio method which required the use of well defined site specific calibration standards. Sample homogenization was the single most important factor influencing data comparability. The site and soil texture variables did not show a measurable influence on data comparability. This demonstration found that the analyzer was generally simple to operate in the field. The operator required no specialized experience or training. Ownership and operation of this analyzer may require

specific licensing by state nuclear regulatory agencies. There are special radiation safety training requirements and costs associated with this type of license. The Niton XL Spectrum Analyzer is an effective tool for field use and can provide rapid, real-time analysis of the metals content of soil samples at hazardous waste sites. The analyzer can quickly identify contaminated areas allowing investigation or remediation decisions to be made more efficiently on site, and thus reduce the number of samples that need to be submitted for confirmatory analysis.
http://www.epa.gov/ORD/SITE/reports/600r97150.htm

Field Portable X-Ray Fluorescence Analyzer: Scitec MAP Spectrum Analyzer. Innovative Technology Verification Report
U.S. EPA, National Exposure Research Laboratory, Las Vegas, NV. Report No: EPA/600/R-97/147, 79 pp, Mar 1998

The U.S. EPA conducted a demonstration of field portable X-ray fluorescence (FPXRF) analyzers in April 1995 at the RV Hopkins site in Iowa and the ASARCO Tacoma Smelter in Washington. The primary objectives of the demonstration were to determine how well FPXRF analyzers perform in comparison to standard reference methods, to identify the effects of sample matrix variations on the performance of FPXRF, to determine the logistical and economic resources needed to operate these analyzers, and to test and validate an SW-846 draft method for FPXRF analysis. The MAP Spectrum Analyzer is manufactured by Scitec Corporation, and was configured to report arsenic, copper, lead, and zinc. The analyzer used a count time of 240 live-seconds, which resulted in a throughput of 9 to 12 samples per hour. The analyzer used one radioactive source, cadmium-109 coupled to a solid-state silicon detector. This FPXRF analyzer is used only in the in situ mode, which means it analyzed samples in minimally disturbed soil. The MAP Spectrum Analyzer can provide rapid, real-time analysis of the metals content of soil samples at hazardous waste sites. The analyzer can quickly distinguish contaminated areas from noncontaminated areas, allowing investigation and remediation decisions to be made more efficiently on-site which may reduce the number of samples that need to be submitted for confirmatory analysis.
http://www.epa.gov/ORD/SITE/reports/143.htm

Field Portable XRF Analysis of Environmental Samples
Kalnicky, Dennis J. (Lockheed Martin Technology Services Group, Edison, NJ); Raj Singhvi (U.S. EPA, Edison, NJ). Journal of Hazardous Materials, Vol 83 No 1-2, p 93-122, 2001

During characterization, removal, and remedial operations at hazardous waste sites, turnaround time associated with off-site analysis is often too slow to support efficient utilization of the data. Field portable X-ray fluorescence (FPXRF) techniques can provide viable and effective analytical approaches to meet on-site analysis needs for many types of environmental samples. Applications include the in situ analysis of metals in soils and sediments, thin films/particulates, and lead in paint.

Field Procedures to Assess Soils and Waste Disposals
Gotzla, A.; W. Riepe, Inst. of Chemistry and Biochemistry, Univ. of Salzburg, Salzburg, Austria. Talanta, Vol 53 No 6, p 1187-1198, 2001

Rapid analytical test methods are needed for arsenic, lead, cadmium, chromium(VI), copper, nickel, and zinc to classify waste materials into waste classes and assess contaminated soils for purification purposes. Rapid ecotoxicological methods have been developed that offer an instrument to comprehensively assess soils and wastes. The developed rapid methods are suitable for the elution of different soils and wastes, the analysis of the eluates and also for wastewaters. This paper describes rapid analytical test methods that can be implemented on site, are of low cost, and take about 30 minutes. Their use is not limited to specialists; they can also be easily applied by persons with some field experience. The comparability of results obtained with the developed rapid test method and standardized methods was tested with various matrices.

Fluid Migration in the Vadose Zone from 3-D Inversion of Resistivity Monitoring Data
Park, Stephen. Geophysics, Vol 63 No 1, p 41-51, 1998

This paper provides an example of electrical resistivity tomography (ERT) to trace fluid plumes.

Fluorescence-Based Sensor Membrane for Mercury(II) Detection
Murkovic, I.; O.S. Wolfbeis. Sensors & Actuators B, Vol 39, p 246-251, 1997

A new type of optical sensor membrane for detection of mercury(II) is composed of plasticized polyvinyl chloride containing a lipophilic borate salt as a reagent for mercury (II), along with an amphiphilic carbocyanine dye as the optical transducer. The sensing scheme is based on the decomposition of the borate anion in the presence of mercury(II). The decomposition cannot be monitored optically, so the borate anion is coupled to the dye cation to form a lipophilic ion-pair, and the decomposition of the borate anion leads to the formation of non-fluorescent dye aggregates that can be followed fluorometrically. The extraction of mercury(II) from the water phase into the membrane leads to a continuous and irreversible decrease in fluorescence intensity. An exposure time of 30 minutes allows the determination of mercury (II) at 100 nM concentration levels. The membrane can be regenerated by exposing it to a solution containing the same borate.

Fluorimetric Flow Injection and Flow-Through Sensing Systems for Cyanide Control in Waste Water
Recalde-Ruiz D.L., Andres-Garcia E. & M.E. Diaz-Garcia, Dept. of Phys./Analytical Chemistry, Univ. of Oviedo, Oviedo, Spain. Analyst, Vol 125 No 11, p 2100-2105, 2000

After developing a flow injection analysis (FIA) system for cyanide determination, the researchers performed experiments to develop a flow-through sensing approach. The systems are based on the interaction between the non-fluorescent copper-calcein complex and cyanide. The proposed methodologies were applied to cyanide determination in natural water samples and in samples coming from an industrial bioreactor to evaluate its effectiveness in the biological cyanide degradation process of metallurgical waste waters.

Fuels in Soil Test Kit: Field Use of Diesel Dog® Soil Test Kits
Schabron, John F.; Susan S. Sorini; Joseph F. Rovani, Jr., Western Research Inst., Laramie, WY, for U.S. DOE, Federal Energy Technology Center, Morgantown, WV. Report No: WRI-01-R009, NTIS: DE00783605. 25 pp, May 2001

Western Research Institute (WRI) is commercializing Diesel Dog® Portable Soil Test Kits for performing analysis of fuel-contaminated soils in the field. The technology consists of a method developed by WRI (U.S. Patents 5,561,065 and 5,976,883) and hardware developed by WRI that allows the method to be performed in the field (patent pending). The method is very simple and does not require the use of highly toxic reagents. The aromatic components in a soil extract are measured by absorption at 254 nm with a field-portable photometer. WRI added significant value to the technology by taking the method through the American Society for Testing and Materials (ASTM) approval and

validation processes. The method is designated ASTM Method D-5831-96, Standard Test Method for Screening Fuels in Soils. This ASTM designation allows the method to be used for federal compliance activities. In FY 99, 25 pre-production kits were successfully constructed in cooperation with CF Electronics, Inc., of Laramie, WY. The kit components work well and the kits are fully operational. In 2000, kits were provided to entities who agreed to participate as FY 99 and FY 00 JSR (Jointly Sponsored Research) cosponsors and use the kits as opportunities arose for field site work. By early 2001, ten kits had been returned to WRI following the six-month evaluation period. On return, the components of all ten kits were fully functional. The kits were upgraded with circuit modifications, new polyethylene foam inserts, and updated instruction manuals.
http://www.osti.gov/bridge/product.biblio.jsp?osti_id=783605

Fundamental Review: Optical Sensors for Determination of Heavy Metal Ions
Oehme, I.; O.S. Wolfbeis. Mikrochimica Acta, Vol 126, p 177-192, 1997

The authors review an optical means for single shot testing ("probing") as well as continuous monitoring ("sensing") of heavy metal ions. The paper provides an introduction to indicator-based approaches, a discussion of the types of indicator dyes and polymeric supports used, and existing sensing schemes for heavy metal ions. The review indicates that considerably more work is needed in terms of selectivity, limits of detection, dynamic ranges, applicability to specific problems, and reversibility.

GE/Nomadics In-Well Monitoring System
Shaffer, Ronald E. (General Electric Corporate R&D, Niskayuna, NY), Radislav A. Potyrailo, Joseph J. Salvo, Timothy M. Sivavec, Joseph R. Wetzel; Joel P. Roark (Nomadics, Inc., Stillwater, OK), Robert Hilley.   Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia

In a two-year program started October 2001, General Electric Corporate Research and Development (GE CRD) and Nomadics, Inc. will develop and validate an automated in-well monitoring system (AIMS) to characterize dissolved- and vapor-phase DNAPLs such as trichloroethene (TCE), in ground water and the vadose zone. The monitoring system takes advantage of low-cost chemical sensor array technology developed by researchers at GE CRD for long-term monitoring of environmental contaminants in ground-water wells. Nomadics will partner with GE to provide scale-up engineering design support, prototyping, and commercialization of the in-well monitoring system technology.
The project has several objectives: 1) adapt GE's sensor array technology to meet DOE needs, 2) integrate the sensor probe into an in-well monitoring system, 3) demonstrate system capabilities during a pilot field test at a selected DOE site, 4) perform a full-scale demonstration of the technology, 5) and develop a commercialization plan for the AIMS technology.
http://www.netl.doe.gov/publications/proceedings/01/indpartner/indpart01.html

Geobotanical Hyperspectral Remote Sensing: State of the Art
Pickles, William L., Lawrence Livermore National Lab. U.S. DOE, National Energy Technology Laboratory website: Technology Status Assessments. 3 pp, Jun 2001

The hyperspectral geobotanical remote sensing techniques being developed use advanced commercial airborne imaging spectrometer systems available in the U.S. and worldwide. The system the researchers normally contract for in overhead imaging missions produces visible and near IR reflected light images with spatial resolution of 1 to 5 meters in 128 wavelength bands. The average spatial resolution of about 3 meters allows detection and discrimination of individual species of plants as well

as the complexities of the geological and man-made objects in the images. Users then can interpret the observed plant species distributions and their relative health along with a detailed understanding of the local geology, and the local human activities. Terrestrial and aquatic plant species, all types of geological formations and soil types, and many different types of human activities can be distinguished. The biological impacts of seepages in large complicated areas can be discerned. These techniques do not require before and after imagery because they use the spatial patterns of plant species and health variations present in the one image to detect and discriminate surface signatures. The spatial resolution allows detection and discrimination of the geobotanical effects of leaks of fluids or gasses from pipelines in large complicated areas such as estuaries, ports, rivers, deserts, forests, grasslands, farmlands, cities, industrial areas, etc. In addition to routine maintenance tasks, accident evaluation and cleanup monitoring is possible for pipeline systems.
http://www.netl.doe.gov/scng/trans-dist/ngi/tech-status.html

Geoelectrical Investigation of Old/ Abandoned, Covered Landfill Sites in Urban Areas: Model Development with a Genetic Diagnosis Approach
Meju, Maxwell A., Univ. of Leicester, Leicester, UK. Journal of Applied Geophysics, Vol 44 No 2-3, p 115-150, May 2000

This paper attempts to develop a genetic investigative model for old or abandoned landfill sites where the records of operations are not available. The main elements of the model are the site boundaries, age and nature of anthropogenic deposits, depth and dip of the layers of refuse and sealing materials, the integrity and shape of the capping zones or separating walls and basal floor slopes, the position of concealed access roads in the site, the water table (or perched water bodies within the refuse), and the presence of leachate. The attendant geotechnical, hydrogeological, and bio-geochemical constraints at such sites are also incorporated in the model for consistency of practical solutions to landfill problems. The main tenet of the model is that vertical conductivity profiles will attain maximum values in the zone of mineral enrichment near the water table and tail-off away from it. This conceptual resistivity model is shown to be consistent with non-invasive observations in landfill sites in different geographical environments. Power-law relationships exist between some geoelectrically important hydrochemical parameters (fluid conductivity, chloride content, and total dissolved solids) in leachates and leachate-contaminated ground water from some landfill sites. A hydrochemical and age-deductive scheme for saturated fill is proposed for geoelectrical models of landfills without significant amounts of metal. Practical suggestions are made for a consistent approach in geoelectrical investigation and diagnosis of old landfill sites. A few field examples illustrate the diagnostic approach.

Geoelectrical Investigations with Hydraulic Conductivity Estimates at Two Waste Disposal Sites
Aristodemou, E. (Imperial College of Science, Technology and Medicine, London, UK; A. Thomas-Betts. 60th European Association of Scientists and Geoengineers (EAGE) Conference and Technical Exhibition, Leipzig, Germany, 8-12 June, 1998 extended abstracts paper 4-50, 1998

Abstract not available.

Geophysical Investigations at a Buried Disposal Site on Fort Richardson, Alaska
Delaney, Allan J.; Jeffrey C. Strasser; Daniel E. Lawson; Steven A. Arcone; Edward B. Evenson.
Report No: CRREL-97-4; NTIS: ADA331135. 20 pp, Sep 1997

The Poleline Road Disposal Area, located on Fort Richardson, AK, was a U.S. Army dump in the early 1950s. In 1990, it was identified as an area potentially contaminated with volatile organic compounds. CRREL conducted extensive geophysical investigations that delineated anomalous responses in many areas of burial within glacial outwash deposits. Ground penetrating radar and electromagnetic induction surveys were used prior and subsequent to excavation. Geophysical data collected on a 5-m grid defined locations for several anomalous areas containing both dispersed and large, discrete targets. Radar defined anomalous areas by the concentration of strong diffractions. The induction survey differentiated metallic from nonmetallic contaminations. The interpreted maximum depth of debris was 4 m. Uncontaminated areas were generally defined by continuous, horizontal radar reflections, suggesting undisturbed or compacted soil horizons. The anomaly maps produced from these surveys guided an excavation that removed hazardous material. The removed material included munitions, mustard gas cylinders, medical waste, steel drums, and other trash. The radar and electromagnetic surveys were repeated using a more closely spaced grid to verify that the excavated areas were clean and to define more precisely anomalies in the areas not excavated. That survey shows many targets of potential or present contamination that should be removed.

Ground Geophysical Surveys for Mine Wastes
DeVos, K.J.; P. Pehme; J.P. Greenhouse. Proceedings of Exploration '97, Fourth Decennial International Conference on Mineral Exploration: Prospectors and Developers Association of Canada, Toronto, ON. p 917-926, 1997

This paper compares DC sounding, VLF, seismic refraction, and TEM methods for tracing an acid mine drainage (AMD) plume below a tailings dam in Canada. The plume was in soil containing many clay lenses, which complicated the interpretations. DC, VLF, and seismic refraction were good at mapping bedrock at 4-25 m depth, but the plume was ambiguous. Of these, VLF was far the fastest and cheapest. TEM did map the plume fairly well, but follow-up drilling was necessary to resolve the issues.

Groundwater Contamination Monitoring with Multichannel Electrical and Electromagnetic Methods
Buselli, G.; Kanglin Lu, CSIRO Exploration and Mining, North Ryde, NSW, Australia. Journal of Applied Geophysics, Vol 48 No 1, p 11-23, Aug 2001

Seepage problems from tailings storage areas at the Ranger minesite in the Northern Territory, Australia, were investigated with electrical and ground-based electromagnetic surveys, i.e., a combination of self-potential (SP), direct current (DC) resistivity, induced polarisation (IP), and transient electromagnetic (TEM) methods. The results were interpreted in conjunction with hydrogeological data. A 64-channel system developed at the Cooperative Research Centre for Australian Mineral Exploration Technologies (CRC AMET) has been used to record simultaneously the response at a number of electrodes with the SP, DC resistivity, and IP methods. A 2-D array of electrodes was set up to monitor the SP response over an area measuring 200 to 300 meters. The simultaneous measurements enable time-varying telluric noise associated with SP responses to be minimized. In-line array DC resistivity and IP measurements were made efficiently at 10-meter station intervals with the multichannel system, e.g. complete Schlumberger soundings centred at 30 separate stations were made in approximately half a day. This paper describes the application of the survey methods and the derived results.

Groundwater Contamination Pathways Identified at Reduced Cost
United States Army Environmental Center. Environmental Update, Vol 14 No 2, Spring 2002

An innovative approach to the interpretation of combined spatial and geophysical analyses of karst terrain saved about $15 million and will expedite investigations at the Pool's Prairie, MO, NPL site. The U.S. Army Environmental Center successfully combined the two kinds of analyses to identify the potential route of ground-water contamination migration at Camp Crowder, MO. USAEC used the approach to determine whether contaminated ground water had migrated into off-post wells. Camp Crowder is situated in a vast karst region. Karst is a type of terrain underlain by soluble carbonate rock (such as limestone) that may allow rapid ground water transport of contaminants through seeps, springs, sinkholes, and fractures. Past investigations at Camp Crowder showed ground-water movement of the contaminants toward the wells, but the actual route of migration was unknown. USAEC successfully combined spatial and geophysical analyses to identify the route of suspected migration through the complex karst pathways. An integrated approach used photo-geologic analysis, airborne electromagnetic surveys, seismic profiling, and two-dimensional electrical resistivity imaging to map subsurface changes. Surface-based geophysical surveys, including seismic refraction and electrical resistivity, mapped the character of the overburden and underlying bedrock. Airborne multi-frequency electromagnetic mapping provided a regional view of the site. Interpretation of the combined data also revealed the source of the contamination, zones of potential underground contaminant storage and several additional potential migration pathways. Karst studies by traditional means can easily cost more than $15 million, but USAEC's innovative approach cost only about $242,000.

Headspace GC-FID and SPME Field Screening for the Determination of C6 to C14 Hydrocarbons in Jet Fuel Contaminated Soils
O'Brien, A.; C.L. MacLeod, Centre for Contaminated Land Remediation, Univ. of Greenwich. European Geophysical Society (EGS) XXVI General Assembly, 25-30 March 2001, Nice, France. Geophysical Research Abstracts, Volume 3, 2001. CD-ROM

Greenham and Crookham commons in west Berkshire, UK are the sites of a decommissioned U.S. airbase. The University of Greenwich has set up a field lab to analyze material excavated from the site, with a threshold of 50 ppm total petroleum hydrocarbons (TPH) for material to be taken off site to a bioremediation facility. Standard methods for TPH determination have not yet been developed for use in the UK, which makes comparison of results from different laboratories and studies very difficult. Headspace gas chromatography presents a fast, efficient, and field-suitable method for determining jet fuel in soils. Headspace parameters have been optimized according to U.S. EPA method 5021, and GC calibration is based on an n-alkane curve C6 to C14. This study presents the results of a comparison between headspace GC and solid-phase microextraction GC, which is a promising technique for hydrocarbon extraction/pre-concentration.

High Resistivities Associated with an LNAPL Plume Imaged by Geoelectrical Tomography
Yang, Chieh-Hou; Jiunn-I You, Inst. of Applied Geology, National Central Univ. Society of Exploration Geophysicists (SEG) 1999. Expanded Abstracts. 4 pp, 1999

In 1996, a rice field in Nankan county, northwestern Taiwan, was flooded a lot of light non-aqueous phase liquid (LNAPL) as a result of a leakage from an underground pipeline. Excavation and removal of the contaminated soil followed shortly thereafter. To monitor and check the effectiveness of the cleanup operation, a pole-pole resistivity imaging survey was carried out one month after the remediation. Of two survey lines, one started from an uncontaminated ground surface and ended at a contaminated surface to distinguish the difference between the subsurface resistivity images underneath a polluted and an unpolluted ground surface. A significant change in resistivity values was detected; a high resistivity value (>140 ohm-m) suggested that the subsurface was contaminated by LNAPL contaminant. The second survey line was conducted on a contaminated ground surface, with final resistivity sections indicating that the subsurface was contaminated by the LNAPL plume. The contaminated zone had a resistivity value greater than 240 ohm-m., and was confined in a depth of 10 meters. Repeated resistivity measurements were carried out again on the same survey lines at 1, 4, and 10 months after the first measurement. These data were used to monitor the temporal variation and a possible spreading of the

LNAPL plume in these two profiles. Another two direct current (DC) resistivity profiling soundings were added to study the spatial distribution of the LNAPL contaminant plume. The final results assess the sensitivity of the DC resistivity profiling method to detect LNAPL plume within a lateritic gravel layer.
http://www.seg.org/meetings/past/seg1999/techprog/detail/NSG2.html

High Resolution Imaging of Vadose Zone Transport Using Crosswell Radar and Seismic Methods
Majer, Ernest L.; K.H. Williams; J.F. Peterson; T.E. Daley, Lawrence Berkeley National Lab., Berkeley, CA. Report No: LBNL-49022, 29 pp, Oct 2001

The seismic and radar survey results together are complementary in their properties estimation, with the radar being primarily sensitive to changes in moisture content, and the seismic being primarily sensitive to porosity. Taken in a time lapse sense, the radar can show the moisture content changes to a high resolution, with the seismic showing high resolution lithology. The radar survey delineated geological layers 0.25 to 3.5 meters thick with 0.25 m resolution, delineated moisture movement and content with 0.25 m resolution, compared favorably with neutron probe measurements, and penetrated up to 30 m. Radar results indicate that the transport of river water is different from that of the heavier and more viscous sodium thiosulfate. It appears that the heavier fluids are not mixing readily with the in situ fluids and the transport may be influenced by them. The seismic survey delineated lithology at .25 m resolution, penetrated over 20 meters with a possibility of up to 30 or more meters, and mapped porosity and density differences of the sediments. The radar and seismic data suggest that the fluid property differences (density, viscosity, surface tension) between the river water and the sodium thiosulfate do make a difference in flow characteristics.
http://www.osti.gov/gpo/servlets/purl/792946-eW976P/native/

High-Resolution Seismic Reflection to Locate DNAPL Source Zones at Hazardous Waste
Battelle, Columbus, OH, and Resolution Resources, Inc., Minneapolis, MN. NFESC TR-2115-ENV, 141 pp, Jun 2000

High-resolution, three-dimensional seismic surveys were conducted and evaluated at four DoD installations to determine if the seismic reflection survey technique could be used to rapidly and effectively perform high-resolution site characterization and DNAPL source detection and delineation. Verification drilling and sampling evaluation of seismically surveyed targets indicated that the high-resolution 3-D seismic surveys could not detect DNAPL contamination of any magnitude existing at the DOD sites. Of the 27 targets evaluated for the presence of DNAPL, only one was found to contain the contaminant. As expected, the seismic-based stratigraphic predictions agreed more closely with observations made during drilling and sampling. Based on the results of this demonstration, it seems doubtful, given the types of conditions that DNAPLs are thought to typically accumulate and reside in the subsurface, whether this seismic method can distinguish between aqueous media and the DNAPLs and/or their dissolved-phase constituents.
http://enviro.nfesc.navy.mil/erb/erb_a/restoration/technologies/invest/geo_phys/tr-2115-high-res.pdf

Hydrotechnics In Situ Flow Sensor. Technology Evaluation Report
U.S. EPA, National Risk Management Research Lab., Cincinnati, OH. Report No: EPA 540-R-02-500, 15 pp, Sep 2001

EPA's Superfund Innovative Technology Evaluation (SITE) Program evaluated the performance of HydroTechnics, Inc. flow sensors in measuring the three-dimensional flow pattern created by operation of the Wasatch Environmental, Inc. (WEI) ground-water circulation well (GCW). The GCW is a

dual-screened, in-well air-stripping system designed to remove volatile organic compounds (VOCs) from ground water. Operation of the GCW creates a ground-water flow pattern that forms a three-dimensional regime known as a circulation cell. EPA's evaluation of the GCW circulation cell involved use of in situ ground-water velocity flow sensors developed at Sandia National Laboratories and manufactured by HydroTechnics, Inc. The flow sensors are in situ instruments that rely on a thermal perturbation technique to directly measure the velocity of ground-water flow in unconsolidated, saturated, porous media. The manufacturer claims that the flow meter can measure horizontal and vertical flow rates and direction in the range is 0.01 to 2.0 feet per day (ft/day) (0.3 to 60.96 centimeter per second [cm/s]). The GCW system was demonstrated at Cape Canaveral Air Station by the U.S. Air Force Center for Environmental Excellence, which provided the data on which this evaluation is based. The primary conclusions of EPA's evaluation of the HydroTechnics flow sensors are as follows: During GCW operation, the ground-water velocities measured by all seven sensors increased by more than 0.1 ft/day, indicating that the sensors were within the circulation cell established by the GCW, and the horizontal extent of ground-water circulation was greater than 15 feet. Flow direction data further support the establishment of a circulation cell and indicate that all the flow sensors are within the horizontal extent of ground-water circulation cell. The demonstration data suggest that the flow sensors are responsive to changes in ground-water flow conditions and can be used to help define and evaluate the three-dimensional flow patterns.
http://www.epa.gov/ORD/SITE/reports/540R02500/540R02500.htm

An Impregnated Filter Sampling Approach for Determination of Hydrogen Cyanide in Air by a Kinetic-Fluorimetric Micellar Method
Sicilia, D.; S. Rubio; D. Perez-Bendito; N. Maniasso; E.A.G. Zagatto, Univ. of Cordoba, Cordoba, Spain.   Analyst, Vol 124 No 4, p 615-620, 1999

The authors describe and assess the performance of a new hydrogen cyanide collecting device based on the use of borosilicated micro-fibreglass filters impregnated with sodium hydroxide. It was used for the determination of hydrogen cyanide in air by a kinetic-fluorimetric method within the 5-600 ng ml-1 range. The method is based on the catalytic effect of cyanide on the oxidation of pyridoxal-5'-phosphate (PALP) by dissolved oxygen in the cationic micellar medium afforded by dodecyltrimethylammonium bromide (DTAB). Common interferences, such as those arising from carbon dioxide, nitrogen oxides, and sulfur oxides did not affect the hydrogen cyanide determination, though interference from hydrogen sulfide could be detected and amended.

In-Situ Permeability Measurements with the Cone Permeameter™ Measurement System
U.S. DOE, Federal Energy Technology Center, Morgantown, WV. Report No: DE-AC21-96MC33124-02, NTIS: DE2001-772546. 112 pp, Jul 1998

The permeability of soil-to-fluid flow defines the magnitude of soil gas and ground-water flow under imposed pressure gradients. Pressure gradients exist due to natural effects such as hydraulic gradients (in the case of ground water) and barometrically imposed gradients (in the case of soil gas). Unnatural gradients are imposed by soil vapor extraction, air sparging, active venting, pump and treat, and other remediation processes requiring the active movement of fluids through the soil. The design of these processes requires knowledge of the flow characteristics of the soil. The most variable of the soil flow characteristics is its permeability, which can vary by several orders of magnitude in a given geologic and hydrologic setting. Knowledge of soil gas permeability is needed to design soil vapor extraction systems and predict the general movement of gas in soil. Saturated hydraulic conductivity, or the soils permeability to liquid flow, is required to predict movement of ground water in saturated soils. The variability of permeability is illustrated by the range of values for different media in a table.

In Situ Spectroscopic Environmental Analysis with Transportable Tunable Dye Lasers
Gillispie, Gregory D., North Dakota State Univ., Fargo. Dept. of Chemistry. Report No: AL/EQ-TA-1996-0023; NITS: ADA356323. 120 pp, Feb 1997

This report summarizes the efforts at North Dakota State University to implement laser-induced fluorescence spectroscopy as a means for sensitive detection of fuel and fuel-related contamination. The work focuses on in situ detection of polycyclic aromatic hydrocarbons in well monitoring or direct push cone penetrometer testing (CPT). The authors discuss conventional approaches to fuel-related detection and their inherent weaknesses. Both laboratory and field studies illustrate the applications of a laser-based, time-domain fluorescence instrument. Principles of fluorescence spectroscopy are outlined and discussed along with issues relating to length of the optical fibers, composite material, cladding, and wavelength dependence.
http://handle.dtic.mil/100.2/ADA356323

The Induced Polarization Method
Slater, Lee D. (Univ. of Missouri at Kansas City); David Lesmes (Boston College, Chestnut Hill, MA). Geophysics 2000: The First International Conference on the Application of Geophysical Methodologies & NDT to Transportation Facilities and Infrastructure, 11-15 December 2000, St. Louis, Missouri

This review summarizes the recent advances and discusses how the IP method can be applied to engineering problems. One potential use of the IP method is hydrocarbon detection. Clay polymerization at a clay-organic interface significantly modifies the surface polarization. The change in polarization magnitude caused by the presence of a hydrocarbon appears to depend on both clay mineralogy and hydrocarbon type. Field studies have also shown that the electrical response of hydrocarbon contaminant varies with time. Given these complexities, further laboratory work is required to fully understand the value of the IP method for hydrocarbon detection; however, controlled field studies have shown that IP imaging of a hydrocarbon contaminant (as illustrated by a perchloroethene case study) is feasible. The IP method may have considerable future use for the detection and monitoring of hydrocarbon contaminants at gasoline storage facilities.
http://www.modot.state.mo.us/g2000/ HAS THIS LINK DIED OR MIGRATED???

Infrared Spectroscopic Analysis of the Sorption Products of Gold Di-Cyanide onto Activated Carbon
Vegter, N.M. (Iscor Ltd., Pretoria, South Africa); R.F. Sandenbergh (Univ. of Pretoria, Pretoria, South Africa), L.C. Prinsloo, A.M. Heyns. Minerals Engineering, Vol 11 No 6, p 545-550, Jun 1998

The infrared peak of CN in $Au(CN)^{2-}$ at 2140 cm^{-1} was detected in mixtures of activated carbon and solid KAu(CN)2 and also in activated carbon exposed to highly concentrated solutions of gold di-cyanide, but they were very weak in the second instance even though the gold concentrations on the carbon were of the same order as in the former case. The infrared peak of CN in $Au(CN)^{2-}$ at 2140 cm^{-1} was not detected in activated carbon exposed to dilute solutions of gold di-cyanide. The detected peaks could be due to KAu(CN)2 salt that crystallized from the concentrates solution during drying. The researchers conclude that once the gold is adsorbed, the IRS technique may not be sensitive enough to detect the adsorbed species.

Initial Development of Continuous Emissions Monitor of Dioxin
Coggiola, Michael J.; Harald Oser; Gregory W. Faris; David R. Crosley, Molecular Physics Laboratory, SRI International, Menlo Park, CA. Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia

The need for a continuous emissions monitor for the determination of dioxins and furans at realistic (ppt or sub-ppt) concentrations in real time (minutes) is widely recognized in the waste combustion community. The key issues are overall sensitivity and selectivity among the many congeners found in real applications. SRI International is completing the development of an instrument based on supersonic jet expansion and cooling, followed by resonantly enhanced multiphoton ionization (REMPI) into a mass spectrometer, which furnishes the dual selectivity of tuned laser absorption and mass analysis. On-line monitoring of stack emissions to determine TEQ values requires, at the minimum, sensitivities at the ppq level, which is far below the detection limit of any current continuous emission monitor. An alternative approach is the real-time measurement of indicator substances, like lowly chlorinated DD/DF isomers, by jet-REMPI.
http://www.netl.doe.gov/publications/proceedings/01/indpartner/indpart01.html

Innovations in Site Characterization -- Technology Evaluation: Real-Time VOC Analysis Using a Field Portable GC/MS
Science Applications International Corporation (SAIC), for U.S. EPA, Office of Solid Waste and Emergency Response, Washington, DC. Report No: EPA 542-R-01-011, 34 pp, 2001

This technology evaluation report describes the use of a field-based measurement technology, the portable INFICON HAPSITE gas chromatograph/mass spectrometer (GC/MS), to measure volatile organic contaminant levels, particularly trichloroethene (TCE), in ground water at the Monterey Peninsula Airport on a real-time basis. The results supported decision-making in the field that guided characterization of the plume and optimal placement of monitoring wells. Real-time application of the technology allowed well installation at a lower cost than if more conventional technologies with a longer turnaround time for results (i.e., conventional off-site fixed laboratory analyses) had been used. In addition to presenting the performance of the HAPSITE GC/MS in the MPA project, this report briefly reviews the HAPSITE's performance in an EPA Environmental Technology Verification (ETV) demonstration that assessed the ability of several field portable instruments (including the HAPSITE GC/MS) to detect and measure VOCs in ground water.
http://www.clu-in.org/download/techdrct/ tdmpa_gc-ms_report.pdf

Installation Restoration Research Program: Assessment of Geophysical Methods for Subsurface Geologic Mapping, Cluster 13, Edgewood Area, Aberdeen Proving Ground, Maryland.
Butler, Dwain K.; M.K. Sharp; K.J. Sjostrom; J.E. Simms; J.L. Llopis. Report Number: WES/TR/GL-96-17; NTIS: ADA319063. 271 pp, Oct 1996

Seismic refraction, electrical resistivity, and transient electromagnetic surveys were conducted at a portion of Cluster 13, Edgewood Area of Aberdeen Proving Ground, MD. Seismic refraction cross sections mapped the topsoil layer and the water table (the saturated zone). The water table elevations from the seismic surveys correlate closely with water table elevations in nearby monitoring wells. Electrical resistivity cross sections reveal a very complicated distribution of sandy and clayey facies in the upper 10 to 15 meters of the subsurface. A continuous surficial topsoil layer correlates with the surficial layer of the seismic section and nearby boring logs. Below the surficial layer, the complicated facies distribution has resistivities ranging from 25 ohm-m (likely clay) to several thousand ohm-m (dry sands and/or gravels). The complexity and details of the electrical resistivity cross section correlate well with boring and geophysical logs from nearby wells. The transient electromagnetic surveys map the Pleistocene-Cretaceous boundary, the saprolite, and the top of the Precambrian crystalline rocks. Conducting the transient electromagnetic surveys on a grid pattern allows the construction of a three-dimensional representation of subsurface geology (as represented by variations of electrical resistivity). Thickness and depth of the saprolitic layer and depth to top of the Precambrian rocks are consistent with generalized geologic cross sections for the Edgewood Area and depths projected from reported depths at the Aberdeen Proving Ground NW boundary using regional dips.

Integrated Geophysical, Geochemical, and Hydrological Study of the Buckeye Mine Tailings, Boulder Watershed, Montana
McDougal, R.M.; B.D. Smith; M.R. Cannon; D.L. Fey. Proceedings, 22nd Annual National Association of Abandoned Mine Land Programs Conference, 24-27 September 2000, Steamboat Springs, Colorado, p 411-428, 2000

EM-31 and EM-34, DC, and magnetics were implemented to investigate a deposit of mill tailings. The EM units gave shallower (EM-31) and deeper (EM-34) details on tailings units and on a plume migrating from a tailings deposit toward a nearby stream. DC gave depth to bedrock, and mag showed ferrous metal junk.

Integrating Remote Sensing and Field Data to Monitor Changes in Vegetative Cover on a Multipurpose Range Complex and Adjacent Training Lands at Camp Grayling, Michigan
Tweddale, Scott; V. Emrick; W. Jackson. Report Number: ERDC/CERL-TR-01-45; NTIS: ADA390993. 49 pp, May 2001

Vegetative cover was inventoried on a multi-purpose range complex (MPRC) and training area adjacent to Camp Grayling, MI, which is a U.S. Army National Guard installation located in the north central area of Michigan's lower peninsula. Remote sensing and field surveys were implemented to determine vegetative cover. In the field, vegetative cover data were collected on systematically allocated plots during the peak of the growing season in 1997. A Landsat Thematic Mapper™ image of the study area was acquired on 8 August 1997 that coincided with field data collection. A Transformed Normalized Difference Vegetation Index (TNDVI) image was derived from spectral information contained within the TM image. Analysis of correlation of vegetative cover measurements from field surveys and TNDVI values derived from satellite imagery were performed. Strong correlations between TNDVI values and several in situ vegetative cover measurements were identified, including Organic Cover (R^2=69.1), Visible Bare Ground (R^2=65.6), Total Cover (R^2=77.6), Total Vegetative and Organic Cover (R^2=79.2), and Total Vegetative Cover (R^2=70.4). Correlations were stronger within the MPRC than the adjacent training area (R^2 for Total Vegetative Cover; MPRC = 70.4, Adjacent Training Area = 53.5). Based on these correlations, spatially explicit vegetative cover estimates were extrapolated across the two training areas. The resulting estimates provided a baseline survey of vegetation cover from which spatial and temporal changes in vegetation cover can be monitored.
http://handle.dtic.mil/100.2/ADA390993

An Integration of Geophysical Methods and Geochemical Analysis to Map Acid Mine Drainage -- A Case Study
Benson, A.K., Brigham Young University. Exploration and Mining Geology, Vol 4, p 411-419, 1996

This paper summarizes the geochemistry of mine waters over an area with many mines. It includes an example of DC Wenner soundings scattered throughout an area to map a plume.

Integration of Electrical Resistivity, Ground-Penetrating Radar, and Very Low-Frequency Electromagnetic Induction Surveys to Help Map Groundwater Contamination Produced by Hydrocarbons Leaking from Underground Storage Tanks
Benson, Alvin K.; Nathan Brett Mustoe. Environmental Geosciences, Vol 5 No 2, p 61-68, Jun 1998

Geophysical surveys were conducted in an area of petroleum-contaminated soil and ground water along strategically located traverses by a unique approach that integrated direct current electrical resistivity (ER), ground-penetrating radar (GPR), and very low-frequency electromagnetic induction (VLF) data. Using multiple geophysical methods can provide cross checks that put reasonable constraints on possible geological models and interpretations. Previous borings at the site supplied information about total petroleum hydrocarbons to enhance interpretation of the geophysical data. The integrated ER, GPR, and VLF data correlated well, and vertical cross-sections generated from the geophysical data helped locate the hydrocarbon plume (both dissolved and free product) delineated as an area of high interpreted resistivities.

Intelligent Unmanned Monitoring of Remediated Sites
Fiesler, Emile; Kisholoy Goswami; Indu Saxena, Intelligent Optical Systems, Inc., Torrance, CA.
Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia

The monitoring technique uses advanced digital signal processing for spectrum analysis to enable accurate, quantitative assessments in situations where the signal to noise ratio is less than 1:1. One possible implementation of the technology includes a self-contained, remote, on-site, continuous monitoring station. Running on solar power plus internal batteries, it can simultaneously monitor several probes contained in a cone penetrometer and inserted in the surrounding terrain, and it can radio an alert whenever it detects more than a pre-set threshold level of contaminants at any of those probes. These pre-set threshold levels can be adjusted in the field, to adapt the unit to different standards of remediation for sites in different locales, or when regulatory requirements change. The monitoring station could employ two separate spectrometers to produce both a Raman and a laser-induced fluorescent (LIF) analysis of the visible and UV spectra of the material surrounding the probes, thus enabling the software to use contaminant signatures from both Raman and LIF processes simultaneously heightening both the sensitivity and reliability of the detection process. In previous work, Intelligent Optical Systems, Inc., demonstrated the feasibility of automated analysis of spectral signals from pure samples of several typical contaminants. The researchers fabricated and tested a prototype system by automatically analyzing Raman spectral data provided by the Westinghouse Savannah River Company. The test demonstrated the ability of the technology to detect the target contaminants (PCE and TCE) in isolation, and also demonstrated this approach's ability to identify the spectra of these contaminants in real-world noisy samples taken from a mixture of materials obtained
from this typical remediation target site. Current work involves enhancing and optimizing the software, preparing it for commercialization, and constructing a prototype instrument by incorporating smart spectroanalysis software and commercially available light sources, spectrometers, and an industry-standard personal computer.
http://www.netl.doe.gov/publications/proceedings/01/indpartner/indpart01.html

Internal Reflection Sensor for the Cone Penetrometer. Innovative Technology Summary Report
U.S. DOE, Office of Environmental Management. Report No: DOE/EM-0611, 34 pp, Sep 2001

The Internal Reflection Sensor, developed by EIC Laboratories, Inc., as a cone penetrometer based technology, provides real-time detection of subsurface non-aqueous phase liquids (NAPLs). The internal reflection element is positioned against the wall of the cone penetrometer probe such that its sensing face is in contact with the soil or ground water as the cone is pushed into the subsurface. When NAPL is present and in contact with the sensing face, the internally reflected light is diminished. This results in a decrease in the signal output by the detector -- a positive indicator of NAPL presence.
http://www.osti.gov/bridge/product.biblio.jsp?osti_id=793530

Investigating Abandoned Mine Reclamation Sites Using Geophysical Techniques
Schueck, Joseph. Proceedings, 22nd Annual National Association of Abandoned Mine Land Programs Conference, 24-27 September 2000, Steamboat Springs, Colorado. p 395-410, 2000

This paper offers a set of examples of electromagnetic (EM), very low frequency (VLF), and magnetic surveys undertaken in abandoned coal mine workings in Pennsylvania. VLF was used to locate fissures where surface water flowed into underground mine workings, to emerge down gradient as acid mine drainage (AMD). Elsewhere, EM units were used to trace edges of coal mine backfill and AMD from backfill. Magnetics were used to find buried tipple refuse (a source of AMD), as well as lost tanks and drums.

Investigations of Geoelectrical Signatures at a Hydrocarbon Contaminated Site
Atekwana, Estella A. (Western Michigan Univ., Kalamazoo); W.A. Sauck; D.D. Werkema, Jr. Journal of Applied Geophysics, Vol 44 No 2-3, p 167-180, May 2000

This study provides an evaluation of the utility and resolution of different geoelectrical methods in mapping contaminant distribution in the subsurface, and provides a window into the processes that may control their response. In situ and 2D surface resistivity, ground penetrating radar (GPR), and electromagnetic methods (EM) constrained by soil boring data were used to investigate the electrical properties of a light nonaqueous phase liquid (LNAPL) contaminant plume that resulted from 50 years of leakage into a glacio-fluvial geologic setting. Overall, the electrical signature from the in situ resistivity measurements were best able to image the subsurface stratigraphy and the associated contamination zone. GPR also mapped the subsurface stratigraphy. In particular, the GPR recorded a reflector running subparallel to the water table and occurring a few meters above the current free product level, which is coincident with the top of an oil-stained, light-gray sand layer. Further, regions of attenuated GPR reflections (shadow zones) due to enhanced conductivities were found to be coincident with low apparent resistivities. 2D geoelectrical measurements successfully imaged the top of the saturated zone and the underlying clay layer, but was unable to resolve any anomalous region that could be attributed to the hydrocarbon contamination, nor did the EM results provide any evidence of the presence of the free product plume at depth.

Joint DOE/EPA JET-REMPI Dioxin CEM Test, Final Report for Joint DOE/EM, EPA, DLR Stuttgart, and Sky+ Test Program to Evaluate JET-REMPI Analyzer as a Continuous Emissions Monitor (CEM) for Dioxins and Other Organics
French, Nina Bergan (Sky +); Brian K. Gullett (U.S. EPA); Harald Oser & H.-H. Grotheer (DLR Stuttgart); David Natschke (Acurex Environmental Corp.). Idaho National Engineering and Environmental Laboratory, 53 pp, Apr 1997

A dioxin CEM offers two solutions to issues surrounding dioxin emissions: first, a method to directly monitor compliance with emissions regulations, and second, a method to advance prevention and control of dioxins before they are released. A Jet-REMPI prototype developed by DLR Stuttgart was tested from July to October 1996 at the EPA National Risk Management Laboratory in Research Triangle Park, NC. The primary test objectives were to establish REMPI parameters (e.g., laser frequency) and measure sensitivity of Jet-REMPI to actual dioxin congeners. The experiments utilized a simple dioxin feeder that fed steady, known concentrations of vapor-phase dioxin species into the Jet-REMPI analyzer. Funding for this project came from the DOE/EM Mixed Waste Focus Area. In addition, EPA provided infrastructure to conduct the test, including facilities, space, and programmatic and technical guidance. DLR Stuttgart provided the Jet-REMPI hardware and labor costs for DLR personnel. The test measured zero-, mono-, di-, and tri- and tetra-chlorinated dibenzodioxins. These may be the first data to show REMPI measurements of tri- and tetra-chlorinated dibenzodioxins. The

data are significant in both indicating detection levels for these dioxins and demonstrating that single-color (one wavelength) Jet-REMPI can measure PCDD congeners up to tetra-levels of chlorination. The data indicate sensitivity of 30 ng/m3 (60 pptv) for 2,7 DCDD (di-chlorodibenzodioxin).
http://tmfa.inel.gov/Documents/jetrempi.pdf

Lab Develops Unique In Situ Water Monitor
EarthVision Environmental News , 19 Oct 2001

A new real-time sensor that can be put directly underground to detect chemicals in the soil and ground water has been developed by researchers at Sandia National Laboratories in Albuquerque, NM. This sensor is seen by the researchers as an important tool in efforts to protect the U.S. water supply. All analyses can be done without taking any samples to a lab.

Lab Power in the Field
Walli, Ron. Trends in Analytical Chemistry, 5 Jun 2001

A point-and-shoot portable instrument developed by Oak Ridge National Laboratory (ORNL) scientist Tuan Vo-Dinh performs analyses in seconds. It is the first battery-operated portable device with tunable filters and performance comparable to that of laboratory-scale instruments. It uses Raman technology, employing a helium neon laser, acoustooptic tunable filters, and a photo sensor to detect toxic chemicals, TNT, byproducts from explosives, drugs, and hundreds of chemicals in either dry or liquid form. Raman technology involves illuminating a sample with a laser beam and measuring the reflected light. Substances are identified on the basis of their vibration energies, which are unique to each compound in the sample. An acoustooptic tunable filter is a solid-state optical bandpass filter that can be tuned to various wavelengths. Because the filter is solid-state and has no moving parts, it is rugged and ideal for this application. The instrument is designed to be used by operators with no special skills. The user merely points a probe at the substance to be tested and touches the start button on the touch-screen display. In 11 seconds, the prototype instrument, dubbed RAMiTS (RAMan Tunable Integrated Sensor), provides a spectral analysis. The final product translates to a readout identifying the chemical or compound. Other team members working on the technology and product are Brian Cullum, Joel Mobley, David Stokes, Alan Wintenberg, Shane Franks, and Bob Maples of ORNL. The project was funded by DOE and the Department of Justice.

Laboratory and Field Assessment of Arsenic Testing Field Kits in Bangladesh and West Bengal, India
Pande, Sunil P.; Leena S. Deshpande; S.N. Kaul, National Environmental Engineering Research Inst. Nehru Marg, Nagpur, India. National Environmental Engineering Research Institute Nehru Marg, Nagpur, 440 020, India. Environmental Monitoring and Assessment, Vol 68 No 1, p 1-18, Apr 2001

The capabilities of five commercially available arsenic detection field kits were evaluated. The authors also recommend generic specifications to form the basis for indigenous manufacture of these kits in arsenic-affected countries. This paper presents the results of the laboratory and field evaluation conducted in Bangladesh and West Bengal, with a comparative ranking of the five arsenic field test kits.

Laser Desorption and Detection of Volatile Organic Compounds from Clay Samples Using a Resonance-Enhanced Multiphoton Ionization (REMPI) Probe
Chen, Kui (Univ. of South Carolina, Columbia); Bill W. Colston (Lawrence Livermore National Lab.,

Livermore, CA), Steve B. Brown; Michael S. Angel (Univ. of South Carolina, Somerset, MA). Pittcon 2002, abstracts, p 99, 2002

Resonance-Enhanced Multiphoton Ionization (REMPI) is a selective technique that gives both quantitative and qualitative information about vapor-phase VOCs. In REMPI, two or more photons interact simultaneously with a molecule to excite and subsequently ionize it. An electrode is biased at a positive potential and collects the electrons produced, which results in a current proportional to the concentration of the species ionized. The researchers are developing a fiber-optic based REMPI probe that can be used to measure VOCs in solid samples. Analyte desorption and ionization are accomplished by the same Nd:YAG laser pulses. The focused laser beam ionizes the VOC vapor near the electrode through a resonant two-photon process. A steady-state concentration of the VOC is established as the laser pulses continue to desorb the compound from clay samples placed beyond the focal point. The ultimate goal of this study is to develop a fiber-optic based REMPI probe to detect aromatic and chlorinated solvents in contaminated soils in a cone penetrometer.

Lateral Migration Radiography Image Signatures for the Detection and Identification of Buried Land Mines
Dugan, Edward T.; Alan M. Jacobs, Florida Univ., Gainesville. NTIS: ADA395436, 152 pp, Aug 2001

Lateral migration radiography (LMR), a new form of Compton backscatter x-ray imaging, is applied to the detection and identification of buried land mines. Uncollimated detectors provide images that are due primarily to single-scatter photons from the soil surface or near-surface. Collimated detectors provide images that are due primarily to multiple-scatter photons from the near-surface or sub-surface. Noise removal and image enhancement techniques including simple weighted filters, Weiner filters, optimal filters and neural networks have been successfully employed on LMR images. Information from both the uncollimated and collimated detector images is used to effectively remove surface clutter and enhance mine detection and identification. An innovative rotating collimator for the x-ray source has been developed to provide rapid side-to-side scanning of the source beam without having to move the x-ray generator in this direction. Acquisition of detailed images of a 40 cm x 40 cm area takes under 30 seconds. The construction and testing of a portable LMR system for outdoor mine detection was completed. This system includes the x-ray generator, rotating source collimator, large area scintillator detectors, system frame assembly, motors and sensors for side-to-side and front-to-rear scanning, x-ray generator scan and data acquisition and processing systems, a standoff-to-vehicle IR modem communication system, and a portable electric generator power system. System weight (not including the vehicle) is about 160 kg, but this initial portable system has been significantly over-designed; system weight for a prototype should be in the range of 80 kg. Power requirement for this system can be as low as 150 watts and will not exceed 800 watts. This portable system successfully acquired images of mines buried in an indoor soil box and then in outdoor tests conducted near the University of Florida campus.
http://handle.dtic.mil/100.2/ADA395436

Leachate Plume Investigations Using Mise-a-la-Masse Resistivity
Lemke, S.R.; C.T. Young. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 22-26 March 1998. Chicago, Illinois, p 839-847, 1998

This paper describes mise-a-la-masse investigations to trace contaminant plumes from landfills in Michigan. The method should also work for tracing acid mine drainage (AMD) plumes.

Leakage Detection in Buried Pipes by Electrical Resistance Imaging
Jordana, Josep; Manel Gasulla; Ramon Pallas-Areny, Univ. Politecnica de Catalunya, Barcelona, Spain.
First World Congress on Industrial Process Tomography, 14-17 April 1999, Buxton, Greater Manchester. p 28-34, 1999

This work describes a non-invasive method to detect leaks in buried pipes that deploys a surface linear electrode array perpendicular to the pipe axis. Two electrodes inject current and the remaining electrodes detect the drop in voltage. The researchers used both the dipole-dipole array and a modified Schlumberger array.
http://www.vcipt.org.uk/congress/proceed.htm

Lidar System for Remote Environmental Studies
Gondal, M.A., J. Mastromarino, King Fahd Univ. of Petroleum and Minerals, Dhahran, Saudi-Arabia.
Talanta, Vol 53 No 1, p 147-154, 2000

A light detection and ranging (lidar) system has been tested for measuring the size of clouds as well as the differential absorption due to pollutant gases like NO2 and SO2 in a cell. The lidar measurements showed strong scattered signals from clouds situated around 11 km above the earth surface and indicated that cloud thickness varied from 0.8 to 3.6 km at various times.

Literature Survey of On-Line Elemental Speciation in Aqueous Solutions
Dasa, Arabinda K. (Univ. of Burdwan, West Bengal, India), Miguel de la Guardia (Univ. of Valencia, Burjassot (Valencia), Spain), M. Luisa Cervera. Talanta 2001, Vol 55 No 1, p 1-28, 2001

Critical examination of the literature concerning online speciation in water reveals that a great deal of work has been performed in this area for most inorganic metal species and some organic compounds, with speciation studies of chromium, selenium, copper, arsenic, lead, cadmium, mercury, iron, aluminum, nickel, tin, antimony, phosphorus, and nitrogen predominating. The literature survey also examined the possibilities and problems of speciation as a function of analytical steps, general strategies involved, and methods proposed for each element or series of elements.

Living with Cyanide
Souren, Angelina W.M.G., Armadillo Research Services. The Geochemical News #105, p 16-26, Oct 2000

This survey paper discusses the use of cyanide in mining and manufactured gas plants, and its dispersal into the environment. It also notes problems in the analysis of cyanide species and complexes, and provides the URLs for a large number of special interest groups currently researching the cyanides and their analysis, fate, and environmental effects.
http://gs.wustl.edu/archives/gn/gn105.pdf

Long-Term Electrical Resistivity Monitoring at the Rice Creek Field Station, Oswego, New York
Valentino, David W. (State Univ. of New York at Oswego); Samuel T. Peavy (Georgia Southwestern State Univ., Americus); Alfred Stamm (State Univ. of New York at Oswego). Geological Society of America Northeastern Section, 37th Annual Meeting, 25-27 March 2002, Springfield, Massachusetts

A long-term resistivity experiment is being conducted at the Rice Creek Field Station in Oswego, NY, to examine the impact of near-surface conditions on resistivity data with the ultimate goal of being able to remove these effects from the data. Electrical resistivity and weather information were monitored over a seven-month period. The electrical resistivity data were collected using an offset Wenner technique with 42 electrodes and an a-spacing of 0.5 m. Weather data monitored included surface and subsurface temperature information to a depth of 1 m, precipitation totals, snow pack, and soil moisture. In an Oswego winter, the ground is generally unfrozen under a snow pack. The water in the soil is at field capacity, but exceeds field capacity during snow melt as the water trickles down through the soil, so that the water in the soil changes with temperature as well as after precipitation. Visual inspection of the data suggested that precipitation and temperature changes could be tracked by changes in electrical resistivity as the change propagates downwards through the subsurface. Resistivity data from different levels were mathematically correlated with the various weather-related measurements. The analysis indicates strong correlations between electrical resistivity values and variations in temperature and precipitation.

Long-Term Monitoring Sensor Network
Farrington, Stephen P.; John W. Haas, Applied Research Associates, Inc., South Royalton, VT. Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia [abstract only]

Labor is the primary contributor to long-term monitoring cost; sample collection, storage, preparation, analysis, and reporting can add a significant financial burden to project expense when extended over many years. Development of unattended, in situ monitoring networks capable of providing quantitative data satisfactory to regulatory concerns has the potential to significantly reduce these costs. Applied Research Associates, Inc. is working to enable facile, remote monitoring of contaminants and other subsurface parameters over prolonged periods through the development of an advanced long-term monitoring sensor network. Three key elements will be developed, integrated together, and field tested under this program: an anti-fouling sensor chamber that can accommodate a variety of chemical and physical measurement devices based on electrochemical, optical and other techniques; two rapid, cost-effective, and gentle means of emplacing sensor packages either at precise locations directly in the subsurface or in pre-existing monitoring wells; and a web browser-based data acquisition and control system (Web-DACS) utilizing field-networked microprocessor-controlled smart sensors housed in anti-fouling sensor chambers. The monitoring network will be highly versatile and can be applied to a variety of subsurface sensing scenarios in different media. However, this project will focus on monitoring water quality parameters of pH, oxidation-reduction potential, conductivity, and temperature in groundwater. The system will be demonstrated beneath a coal pile run-off basin at the Savannah River site in South Carolina.

Low-Frequency Conductivity Measurements to Monitor Ionic Migration through Landfill Liners
Blewett, Jo (Heriot-Watt Univ., UK); W.J. McCarter; T.M. Chrisp; G. Starrs. Third BGA Geoenvironmental Engineering Conference, 17-19 September 2001, Edinburgh, Scotland, UK

This paper considers the technical aspects associated with low-frequency conductivity measurements within liner materials. Experimental work is presented to show the direct application of electrical techniques to track ionic movement through clay under a chemically induced flow. Possibilities for the development of the testing methodology to include coupled flow measurements, and the potential for field monitoring of liner systems is discussed

Low Range Differential Pressure (LRDP) Leak Detection System
United States Army Environmental Center. Fielding Environmental Solutions, Apr 2002

The Naval Facilities Engineering Service Center (NFESC), Port Hueneme, CA, and its industrial partners, Vista Engineering Technologies, LLC, and Vista Research, Inc., have designed, fabricated, installed, and evaluated the performance of the Low-Range Differential Pressure (LRDP) leak detection system in a 12,500,000-gal underground storage tank (UST). The LRDP system is comprised of an innovative in-tank level sensing unit, a remote test controller to collect and analyze the data from a test, and a host computer to initiate, report, and archive results. The performance of the LRDP system was evaluated for a 24-hour test by an independent third-party evaluator (Ken Wilcox Associates, Inc.). The performance was determined experimentally and reported in accordance with “Alternative Test Procedures for Evaluating Leak Detection Methods: Evaluation of Bulk Field-Constructed Tanks,” a standard test procedure for bulk underground tanks. The evaluation consisted of 12 tests conducted in one tank, which was filled to a depth of 226.55 feet and contained 12,154,000 gallons of jet fuel. The results of the third-party evaluation indicate that with a single 24-hour test, the LRDP-24 can detect a leak of 0.59 gal/h with a probability of detection of 95% and a probability of false alarm of 5%. The performance can be improved by averaging two or more tests together. By averaging nine tests together, the LRDP-24-n can detect a leak as small as 0.2-gal/h with the same probabilities of detection and false alarm. The threshold used to operate the system can be selected by the operator to minimize false alarms and still maintain an acceptable level of detection. The system is fully approved and ready for implementation in bulk UST's. The system can also be used in bulk aboveground storage tanks (ASTs). Tests are being conducted over the next few months to verify the LRDP's performance in both fixed roof and floating pan tanks. For additional information on the LRDP, contact Leslie Karr, NFESC, at (805) 982-1618 or karrla@nfesc.navy.mil.

Magnetic Properties of Alluvial Soils Contaminated with Lead, Zinc and Cadmium
Petrovsky, E. (Acad. Sci. Czech Rep., Prague, Czech Republic), A. Kapika, N. Jordanova; L. Borvka (Czech Univ. of Agriculture, Prague, Czech Republic). Journal of Applied Geophysics, Vol 48 No 2, p 127-136, 2001

The authors analyzed the magnetic characteristics of alluvial soils formed as a result of several breakdowns of wet deposit sink of ashes from a lead ore smelter. The soils are known to contain concentrations of lead, zinc, and cadmium. The results show that in the case of a shared source of heavy metals and magnetic minerals, simple measurements of magnetic susceptibility discriminate well between polluted and clean areas. In addition, the concentration pattern agrees with the concentrations of the heavy metals studied in deeper soil layers that were not affected by post-depositional changes due to climate and remediation efforts.

Management System for Fluid Storage Tanks at Fort Lewis, WA
Northrup, Jearldine I.; Baird, Joyce C.; Schiller, Donald J.; Lee, James F., Department of the Army, Fort Lewis, WA. Report No: ERDC/CERL-TR-01-27; NTIS: ADA388102. 38 pp, Mar 2001

The U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) was tasked with electronically consolidating fluid storage tank information for underground storage tanks (USTs) and aboveground storage tanks (ASTs) at Fort Lewis Military Reservation, WA. The work described in this report completed the first of three steps to monitor storage tanks at Fort Lewis by demonstrating an integrated storage tank monitoring system of limited scope. Later work will assess methods to connect all regulated tanks to the monitoring system computer, and a third task will connect as many of the remaining unregulated tanks to the monitoring system as possible.
http://handle.dtic.mil/100.2/ADA388102

Mapping Agricultural Fields with GPR and EMI to Identify Offsite Movement of Agrochemicals
Yoder, Ronald E.; Robert S. Freeland; John T. Ammons; Leroy L. Leonard, Univ. of Tennessee, Knoxville. Journal of Applied Geophysics, Vol 47 No 3-4, p 251-259, 2001

A study combined traditional surveying with electromagnetic induction (EMI) and ground-penetrating radar (GPR) mapping to identify areas with high potential for subsurface off-site movement of agrochemicals, optimizing these identification techniques, and expanding the mapping procedures to make them useful at the field-scale for agricultural production practices. The researchers conclude that EMI mapping provides rapid identification of areas of soil with a high electrical conductivity and presumably high potential for off-site movement of subsurface water; GPR mapping of areas identified by EMI mapping provides a means to identify features that are known to conduct concentrated lateral flow of water; and combining the capabilities of EMI and GPR instrumentation makes possible the surveys of large areas that would otherwise be impossible or unfeasible to characterize.

Mapping Groundwater Contamination Using DC Resistivity and VLF Geophysical Methods: A Case Study
Benson, Alvin K.; Kelly L. Payne; Melissa A. Stubben. Geophysics, Vol 62 No 1, p 80-86, Jan-Feb 1997

Electrical resistivity (ER) and very low-frequency (VLF) electromagnetic induction geophysical surveys were carried out in Utah County, UT, to determine the extent of hydrocarbon contamination beneath a leaking underground gasoline tank. Both VLF and ER successfully demonstrated the extent of the hydrocarbon contamination, and in combination produced a clear picture of the hydrocarbon plume. Even though the total dissolved solids (TDS) in the contaminated water increased its conductivity, the plume was found as a resistivity zone due to the presence of high resistivity hydrocarbons floating on top in the vadose zone. The VLF was particularly useful in delineating the extent of the plume using broad areas of low conductivity.
http://www.science.ubc.ca/~eoswr/geop/appgeop/stucases/g7/g7.html

Metal Ion Analysis Using Near-Infrared Dyes and the "Laboratory-on-a-Chip"
Collins, Greg E. (Naval Research Lab., Washington, DC); Qin Lu (GeoCenters, Inc.). U.S. DOE Project Number 64982, Final Report. 16 pp, 2002

The purpose of this project was to establish the groundwork for developing a portable, toxic metal ion sensor capable of sensitively and rapidly detecting trace levels of hazardous waste metal ions contaminating building materials. By enabling selective metal ion analysis in the field, timely decisions with regards to the proper choice of remediation tools to be applied in a given activity, accurate sorting of contaminated and uncontaminated materials, and the immediate determination of the success or failure of a given cleanup effort can be assessed directly, in real time. Such a sensor would bring about savings in time and money and minimize human exposure. The sensor being developed is based on a small glass slide with small microchannels etched upon its surface that enable capillary electrophoretic separations to be performed on a microscale. The researchers have studied the synthetic coupling of fluorescent tags with macrocycles known to complex toxic metal ions, and the subsequent utilization of these molecules to enable the sensitive and selective separation of metal ions such as uranium on a microchip. The rapid separation of seven different toxic metal ions has been demonstrated, including cobalt, nickel, and cadmium in under a minute utilizing the chromophore, PAR. Rhodamine-calix[6]arene was synthesized and shown on the microchip to be a highly selective chelating agent for uranium in the presence of various metal ion impurities. Arsenazo III was investigated both on chip and in the form of a remote fiber optic probe for the selective detection of uranium down to the low ppb range. By demonstrating the rapid and sensitive separation of uranium and

various other metal ions on a capillary electrophoresis glass microchip, this project has made significant advancements towards the realization of a portable sensor for toxic metal ions.
http://www.osti.gov/em52/final_reports/64982.pdf

Method Comparison for the Determination of Total Cyanide in Deposited Blast Furnace Sludge
Mansfeldt, T.; H. Biernath, Faculty of Geosciences, Univ. of Bochum, Bochum, Germany. Analytica Chimica Acta, Vol 435 No 2, p 377-384, 2000

The authors determined the total cyanide in 32 samples of a disused blast furnace sludge deposit using two methods. The first method is based on a weigh-in of solid material followed by an acid digestive distillation. At a distillation time of 1 hour (the German standard method), total cyanide is underestimated. At a distillation time of 2 hours, the cyanide determination is quantitative. Results of these modifications of the German standard method were statistically equal to those obtained by the second method, an alkaline extraction using 1 M sodium hydroxide repeated three-fold, and followed by an acid digestive distillation of the extracts. On average, 85% of total cyanide was dissolved in the first extract, 12% in the second, and 3% in the third. Determination of total cyanide in deposited blast furnace sludge can be performed by an acid digestive digestion of solid material for 2 hours, as well as by a repeated extraction by means of 1 M sodium hydroxide.

A Methodology for Determining the Deportment of Cyanide Losses in Gold Plants
Adams, Mike D. Adams (Lakefield Oretest, Kewdale, WA, Australia. Presented at Hydromet 2000, Adelaide, Australia. Minerals Engineering, Vol 14 No 4, p 383-390, Apr 2001

This paper presents a simple methodology using thermodynamic constants and solution analyses to determine the speciation and deportment of cyanide in gold plant liquors and solids. Samples with different ore mineralogies and chemistries were assayed using the methodology and compared with results obtained by direct measurement using several other techniques. The newly developed methodology enables cyanide deportment information to be obtained relatively easily. Meaningful analysis of cyanide in the presence of copper is obtained, because the changing equilibrium levels of the copper cyanide complexes are taken into account. Thiocyanate can account for a considerable amount of the cyanide that is consumed. The loss of cyanide due to volatilization can be significant in highly saline solutions, and this cam be estimated also.

Microscopic X-Ray Fluorescence Analysis
Janssens, Koen H.A.; Freddy C.V. Adams; Anders Rindby. Wiley-Interscience, New York. ISBN: 0-471-97426-9, 434 pp, 2000

In the last 10-15 years many analytical advances in X-ray fluorescence analysis (XRF) have taken place, giving rise to non-destructive ultrasensitive surface analyses of materials. One of the variants of XRF developed is micro-XRF (5-XRF), which is able to analyze the distribution of major, minor, and trace elements in microscopic sample surface areas. Due to the availability of commercial instrumentation and the development of simple devices for focusing X-rays, 5-XRF has increased in popularity and is able to fill the gap between bulk X-ray fluorescence and electron probe X-ray microanalysis (EPXMA). This text is the first single volume to bring together introductory and advanced information on the essential aspects of the technique, thereby providing an excellent overview of the developments and applications of 5-XRF. Topics discussed in the book include interaction of X-rays with matter, micro-focusing X-ray optics, instrumentation for 5-XRF with laboratory and synchrotron sources, evaluation and calibration of 5-XRF data, and comparison of 5-XRF to other microanalytical techniques. The final chapters of the book describe applications of 5-XRF in the geosciences, in art and archaeology, in environmental and biological science, and for industrial purposes.

Microsensors for Ultrasensitive Detection of Hexavalent Chromium in Groundwater
Thundat, Thomas G. (Univ. of Tennessee, Knoxville, and Oak Ridge National Lab., Oak Ridge, TN); Lal A. Pinnaduwage; Gilbert G. Brown. Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia [Abstract only]

The researchers have conducted preliminary studies on the detection of hexavalent chromium in ground water using microcantilevers modified with self-assembled monolayers of triethyl-12-mercaptododecylammonium bromide. The self-assembled monolayer was prepared on a silicon microcantilever coated with a thin layer of gold on one side. The microcantilever undergoes bending due to sorption of CrO4 2- ions on the monolayer-modified surface. These studies demonstrated the detection of hexavalent chromium with a sensitivity of 52 nanograms per liter under laboratory conditions. In situ, portable sensors will be developed for continuous monitoring of hexavalent chromium in ground water using adsorption-induced stress on micromachined microcantilevers. In Phase I, techniques will be developed to optimize cantilever response to hexavalent chromium ions and to minimize the overall response of the detector to interferences such as other chemicals and variations in ambient temperature, pressure, vibration, etc. In Phase II, field portable sensors will be developed and demonstrated.

Microwave Radar Sensing of Gas Pipeline Leaks
Gopalsami, N.; A.C. Raptis, Argonne National Lab., Argonne, IL. U.S. DOE, National Energy Technology Laboratory website: Technology Status Assessments. 9 pp, Jan 2002

This report presents a state-of-the-art survey of remote sensing techniques in the context of detection and location of natural gas leaks. There is a wealth of literature on optical remote sensing techniques that includes laser-based spectroscopic systems. These optical techniques are briefly described along with their advantages and limitations. Even though microwaves are routinely used for satellite-based weather forecasting and remote sensing of earth resources, little literature has been published about leak detection with microwaves. Stemming from past work in microwave and millimeter-wave chemical detection, the basis of a leak detection method based on microwave pulsed radars is described and their potential for gas pipeline leak imaging assessed.
http://www.netl.doe.gov/scng/publications/microwave_radar.pdf

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

At the tailings dam of a disused pyrite mine in South Australia, the ground water is affected by the discharge of sulphuric acid from the tailings. Results of geophysical surveys show that it is difficult to determine any preferred channels of ground-water flow from self potential (SP) profiling data alone, but transient electromagnetic (TEM) and direct current (DC) resistivity sounding measurements have enabled accurate determination of water-table levels and ground-water resistivity. Innovative geophysical methods have been proposed for detecting and monitoring seepage from structures where ore, waste rock, and ore processing wastes are stored or treated, including a new multi-channel system for simultaneous electrical measurements using a new type of electrode with very low inherent noise.

A Model for the Resistivity Structure of LNAPL Plumes and Their Environs in Sandy Sediments
Sauck, William A., Inst. for Water Sciences, Western Michigan Univ., Kalamazoo. Journal of Applied Geophysics, Vol 44 No 2-3, p 151-165, May 2000

The major geophysical response of a mature or established fuel spill is due to an anomalously low resistivity zone in the lower vadose zone and upper portion of the aquifer. This zone is produced by a high total dissolved solids leachate that is flushed down aperiodically from the mixed hydrocarbon, water, oxygen, and soil near the base of the vadose zone where microbial activity is a maximum. The leachate is a result of acidification by organic and carbonic acids of the water-filled capillaries in the heterogeneous mixing zone at the free/residual product level, and is produced by the leaching and etching of the native mineral grains and grain coatings. This conductive inorganic plume is generally coincident with the uppermost part of the anaerobic dissolved hydrocarbon plume as defined by hydrochemical studies, but is thin and most concentrated at the top of the aquifer. It has been best detected and mapped by virtue of the amplitude shadow it causes on ground penetrating radar (GPR) profiles, and more recently by direct measurement using vertical resistivity probes (VRP) with readings every 5.08 cm from the surface to more than 7.5 m in depth. Other surface electrical geophysical methods (VES, electromagnetic method (EM), and multi-spaced horizontal resistivity profiling) can define this zone only if conditions are optimal.

Modular Robotics for Delivering On-Site Contamination Sensors and Mapping Systems to Difficult-to-Access Locations
Black, Derek D., ARM Automation, Inc., Austin, TX. Industry Partnerships for Environmental Science and Technology Conference, 30 Oct-1 Nov, 2001. 11 pp, 2001

By using its modular approach to robotic systems, ARM Automation will provide one of many possible custom, portable and dexterous robotic systems for positioning sensors in a contaminated environment. This "Lego-like" robot system will be mounted a mobile platform and equipped with cameras and other sensors that will enable a remote operator to quickly and safely designate numerous locations for semi-autonomous inspection and mapping.
http://www.netl.doe.gov/publications/proceedings/01/indpartner/indpart01.html

Molecular Recognition and Self-Assembled Polymer Films for Vapor Phase Detection of Explosives
Yanga, X.; X.-X. Du; J. Shi; B. Swanson, Los Alamos National Lab., Los Alamos, NM. Talanta, Vol 54 No 3, p 439-445, 2001

Selective and sensitive polymer films for detecting explosives were studied and fabricated onto surface acoustic wave (SAW) devices. Polymers and molecular host species were self-assembled on functionalized silicon oxide surfaces through a catalytic hydrosilylation reaction. The microsensors coated with stable, covalently attached, thin polymer films show high sensitivity towards DNT and o-nitrotoluene, an explosive simulant. Sensor sensitivities to possible common interferents in land mine detection were found to be much lower than that to DNT and explosives simulants. After response patterns were constructed for interferants and o-nitrotoluene, sensors coated with functionalized cyclodextrins were able to detect TNT and 2,4-DNT under ambient laboratory conditions.

Monitoring Atmospheric Metal Pollution: A Review of the Use of Mosses as Indicators
Onianwa, P.C., Dept. of Chemistry, Univ. of Ibadan, Ibadan, Nigeria. Environmental Monitoring and Assessment, Vol 71 No 1, p 13-50, Sep 2001

This article reviews the literature on the use of mosses for monitoring atmospheric metal pollution. It discusses the nature of mosses, the mechanisms for moss uptake of metals from the air and wet precipitation, the various forms in which mosses are used for this purpose, and cases in which mosses have been used for monitoring local pollution hot spots and regional patterns of metal pollution. The author also addresses interspecies differences, and compares the effectiveness of mosses with other indicator materials.

Multibiosensor Based on Enzyme Inhibition Analysis for Determination of Different Toxic Substances
Arkhypova, V.N. (Inst. of Molecular Biology & Genetics, National Acad. of Sciences of Ukraine, Kiev, Ukraine), S.V. Dzyadevych, A.P. Soldatkin, A.V. El'skaya; N. Jaffrezic-Renault (IFoS, UMR/CNRS, Ecole Centrale de Lyon, Ecully Cedex, France), H. Jaffrezic, C. Martelet. Talanta, Vol 55 No 5, p 919-927, 2001

An original concept of an enzyme multibiosensor for determination of toxic substances based on enzyme inhibition analysis has been constructed with two types of transducers—potentiometric pH-sensitive field-effect transistors and conductometric thin-films interdigitated electrodes—and three enzymes—urease, acetylcholinesterase, and butyrylcholinesterase. The experimental data have been treated by multivariate correspondence analysis. The paper presents a complete procedure for a simultaneous determination of some heavy metal ions and pesticides.

Multisensor System on the Basis of an Array of Non-specific Chemical Sensors and Artificial Neural Networks for Determination of Inorganic Pollutants in a Model Groundwater
Rudnitskaya, A. (St. Petersburg Univ., St. Petersburg , Russia); A. Ehlert (Technical Univ. of Braunschweig, Braunschweig, Germany); A. Legina (St. Petersburg Univ., St. Petersburg , Russia), Yu. Vlasov; S. Bettgenbach. Talanta, Vol 55 No 2, p 425-431, 2001

A multisensor system for ground-water monitoring is based on an array of non-specific potentiometric chemical sensors with data processing by artificial neural networks. The system includes 13 sensors with PVC membranes and 12 solid-state ones. The authors present the results of measurements in model solutions containing heavy metals, alkali- and alkali-earth cations, and inorganic anions. Both the PVC and solid-state sensors can be used separately for determination of the described ions, but the best results are obtained if the whole array of sensors is used.

Near Infra-Red Absorption Tomography for Measurement of Chemical Species Distribution
Carey, S.J. (Dept. of Electrical Engineering & Electronics, UMIST), H. McCann; D.E. Winterbone (Dept. of Mechanical Engineering, UMIST), and E. Clough. First World Congress on Industrial Process Tomography, Buxton, Greater Manchester, 14-17 April 1999. p 480-487, 1999

The study of systems containing liquid reactants has shown the benefits of electrical resistance tomography for measurement of species distribution. In cases where there is no contrast due to bulk physical or electrical properties, there are presently very few techniques available to the researcher or process engineer that enable access to the distribution of chemical species. This paper presents an infrared tomography technique that is applicable to the measurement of gaseous hydrocarbon distributions. The measurement of the distribution of gaseous species is of importance for applications such as pollution monitoring and combustion research. The particular application targeted is the measurement of gasoline vapor distribution within the combustion chamber of an internal combustion engine.
http://www.vcipt.org.uk/congress/proceed.htm

Negative Ion Sensors for Real-Time Downhole DNAPLs Detection
Gillispie, Gregory D., Dakota Technologies, Inc., Fargo, ND. NTIS: ADA399917, 107 pp, Mar 2002

This final report summarizes the findings of a three-year R&D project aimed at improved methodology for locating chlorinated solvent contamination in the subsurface. Current subsurface sampling methods (soil cores, split spoon) provide widely spaced data points for economic considerations and may be less than accurate because of the volatility of some species. Direct detection of subsurface contamination alleviates many of these negative factors, but itself brings additional difficulties such as contending with the water table. Direct push technology offers a promising alternative to the conventional approaches and has proven very useful in characterizing subsurface hydrocarbon contamination using laser induced fluorescence technology. The effort reported here employs a patented Membrane Interface Probe (MIP) to allow mass transfer across the MIP from the soil matrix to a carrier gas internal to the cone penetrometer. Placing the detector downhole allows immediate detection of the volatile compound requiring only the electrical signal to be transferred to the surface. During this effort three technologies were demonstrated for subsurface detection, a halogen-specific detector (XSD), a photoionization detector (PID), and a photoemissive electron capture detector (PE-ECD). Each was demonstrated at known contaminated sites with favorable results.
http://handle.dtic.mil/100.2/ADA399917

New Technical Guidance for MTBE Site Characterization
Nichols, Eric M. (LFR/Levine·Fricke, Emeryville, CA); Murray D. Einarson (Conor Pacific EFW); Steven C. Beadle (LFR/Levine·Fricke, Irvine, CA). Petroleum Hydrocarbons and Organic Chemicals in Ground Water--Prevention, Detection, and Remediation, 17-19 November 1999, Houston, Texas. Proceedings. National Ground Water Association, and American Petroleum Institute, p 348-353, 1999

The American Petroleum Institute has produced a technical guidance document, ‘MTBE Site Characterization Technical Bulletin,’ (1999) for the appropriate characterization of sites with subsurface releases of fuel oxygenates. The publication includes an introduction to the properties and uses of MTBE, provides guidance for conducting assessments at MTBE release sites, and reviews modern assessment tools and techniques for characterizing and monitoring MTBE in the subsurface. The publication provides an overview of the expedited site assessment approach and a detailed guide to current direct-push assessment and monitoring tools, with emphasis on their proper use at MTBE-affected sites.
http://www.solinst.com/Sitemap/sitemap.html

Non-Invasive Determination and Monitoring of Free-Phase Dense Nonaqueous Phase Liquids (DNAPLS) by Seismic Reflection Techniques
Waddell, Michael G. (Earth Sciences and Resources Inst., Univ. of South Carolina, Columbia); William J. Domoracki; Tom J. Temples. Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia. 3 pp, 2001

Traditional methods used to determine location and extent of DNAPL contamination require point-source data obtained from invasive methods such as borehole geophysical logs and cone penetrometer data. These invasive methods not only run the risk of cross-contamination of an aquifer, but also may not locate pools of contamination because of inadequate spatial coverage. The seismic reflection method provides a non-invasive means to acquire spatially dense subsurface information. Typically, a two-dimensional high-resolution seismic reflection survey may have data points only a foot apart. A three-dimensional seismic reflection survey, because of the greater cost involved, may have data points every 5 feet throughout a regular grid. Vertical resolution of a typical high-resolution seismic reflection survey is three to five feet. These data, combined with existing borehole information, can provide a detailed picture of the subsurface. Research has been conducted at the following sites where DNAPL contamination is known to be present: Savannah River Site, SC, Hanford Reservation, WA, and Charleston Naval Weapons Station, SC. Seismic reflection surveying and seismic reflection AVO analysis are noninvasive techniques that, under certain circumstances, provide a means of mapping subsurface lows where DNAPL might accumulate and directly detecting the presence of free- phase DNAPL in the subsurface. This approach significantly reduces the cost of site characterization and prevents cross-contamination between aquifers by reducing the number of monitoring wells. The seismic reflection survey is the only subsurface remote sensing method capable of providing dense spatial sampling of subsurface material properties at depths 15 feet and greater. http://www.netl.doe.gov/publications/proceedings/01/indpartner/indpart01.html

Novel Mercury (II) Ion-selective Polymeric Membrane Sensor Based on Ethyl-2-benzoyl-2-phenylcarbamoyl Acetate
Hassan, Saad S.M. (Ain Shams Univ., Cairo, Egypt), Mohamed B. Saleh; Ahmed A. Abdel Gaber (Minia Univ., Minia, Egypt), Ramadan A.H. Mekheimer, Nahed A. Abdel Kream. Talanta, Vol 53 No 2, p 285-293, 2000

A mercury(II) ion-selective PVC membrane sensor based on ethyl-2-benzoyl-2-phenylcarbamoyl acetate (EBPCA) as a novel nitrogen-containing sensing material exhibits good linear response of 30 mV per decade within the concentration range 10-6 -- 10-3 mol l-1 Hg(II). The sensor shows good selectivity for mercury(II) ion compared with alkali, alkaline earth, and transition and heavy metal ions. The sensor is suitable for use with aqueous solutions of pH 2.0-4.5 and exhibits minimal interference by Ag(I) and Fe(III). The sensor was applied to the determination of Hg(II) content in some amalgam alloys with results correlating well with data obtained by atomic absorption spectrometry.

A Novel Metal Sensor for Real-Time Monitoring
Shaub, Walter. Analytical Chemistry, Vol 74, p 664-670, 2002

A sensitive, real-time monitor for detecting heavy metal ions in solution has been developed by Jacques Buffle and colleagues at Geneva University in Switzerland. The sensor couples fiber optics to a permeation liquid membrane and is the first sensing system built for metal-ion detection that combines the separation and preconcentration capabilities of permeation liquid membranes (PLM) and fluorescence detection with an optical fiber. The Swiss scientists developed a system for detecting Cu(II) ions. The sensor can achieve a detection limit for Cu(II) of ~50 nM. Among five tested heavy metal ions—Co(II), Ni(II), Cd(II), Zn(II), and Pb(II)—Pb(II) was the only major interfering species. To construct the sensor system, a strip solution, in which Cu(II) is accumulated, was placed in the lumen of a hollow fiber. Calcein, a fluorochromic dye, was used as a stripping agent and, at the same time, as an indicator of the metal being analyzed. Cu(II) accumulation is driven by the gradient of the free analyte concentration between the source and strip solutions. Quenching of calcein fluorescence upon metal accumulation in the strip phase is detected using a multimode optical fiber incorporated into the lumen. The calcein fluorescence was excited using a blue LED and detected using a photon counter. PLMs can enable selective detection of many trace compounds (metal ions, carboxylic acids, and alcohols) with high sensitivity.

On-Line Determination of Cyanide in the Presence of Sulfide by Flow Injection with Perevaporation
Sulistyarti, H. (La Trobe Univ., Bundoora, Vic., Australia); T.J. Cardwell; M.D. Luque de Castro; S.D. Kolev. Analitica Chimica Acta, Vol 390, No 1-3 p 133-139, 1999

In a pervaporation-flow injection (PFI) method for the analysis of cyanide in the presence of sulfide, the interfering sulfide ion in the injected sample is precipitated online using an acidified lead nitrate reagent solution before the donor stream enters the pervaporation cell. Linear calibration was obtained in the range 0.02-100.0mgl^{-1} with a detection limit of 1.0µgl^{-1} using amperometric detection at a silver electrode set at -50mV (vs Ag/AgCl). Sample throughput was of the order of 12-15h^{-1}. No significant interference from sulfide was evident at concentrations up to 50mgl$^{-1,}$ or from thiocyanate at levels up to 1000mgl^{-1}.

On Site PCB Analysis in Support of a Transformer Rebuilding Project
Li, Ken (Environment Canada, Ottawa, Ont., Canada), Michael Landriault, Merv Fingas; Albert Potvin (Natural Resources Canada, Ottawa, Ont., Canada). Journal of Hazardous Materials, Vol 83 No 1-2, p 123-134, 2001

A gas chromatograph with electron capture detector (GC/ECD) mounted in a mobile laboratory was deployed to conduct miscellaneous PCB analyses at a transformer-rebuilding project. Extensive comparison of GC and the quick test Clor-N-Oil kit were also carried out and showed generally good agreement. The use of an on-site GC was crucial in providing rapid and accurate analysis on site, thus, enabling quick modifications to the decontamination strategies to meet the target PCB level. For projects of this nature, a GC/ECD was far superior to quick test kits by providing the selectivity and sensitivity for the diverse nature of the sample media.

Optically-Based Array Sensors for Selective In Situ Analysis of Tank Waste
Brown, Gilbert M. (Oak Ridge National Lab., Oak Ridge, TN), Reza Dabestani, and Peter V. Bonnesen; David R. Walt (Tufts Univ.); Hai Feng Ji (Oak Ridge National Lab.) and R. L. Hettick; Caroline L. Schauer (Tufts Univ.). U.S. DOE Project Number 60217, Final Report. 25 pp, 2001

The objective of this research program is to conduct the fundamental research necessary to develop an array of chemically selective sensors based on highly selective molecular recognition agents and highly sensitive fluorescence techniques that can be coupled to fiber optics for remote analytical applications. The team is developing a fluorophore-selective ligand combination needed for a Cs+ selective fluorescence sensor. Calix[4]bis-crown-6-ethers in the 1,3-alternate conformation have been shown to possess a high degree of selectivity for cesium over sodium and moderate selectivity for cesium over potassium. Several systems involving the preparation of a new class of calixarene-based ionophores having attached fluorescent probe molecules were demonstrated. Cyanoanthracene attached to the benzyl group of a benzo crown was prepared as the first generation of a cesium selective optical sensor. The fluorescence of the 9-cyanoanthracene is quenched by the benzo moiety of a crown ether owing to a Photoinduced Electron Transfer (PET) process. Binding the oxygen electron pairs of the benzo moiety upon metal ion complexation partially suppresses the PET process, allowing the fluorescence of the cyanoanthracene to increase. The synthesis of a 1,3-alternate di-deoxygenated calix[4]arene-(9-cyano-10-anthrylmethyl)-benzocrown-6 as the second generation cesium selective fluorescent probe has been accomplished. This probe shows a 54-fold fluorescence enhancement response upon cesium complexation. The observed selectivity ratios (Na/Cs and K/Cs) are consistent with data reported for other 1,3-alternate calix[4]dialkoxy-crown-6 derivatives. Preliminary work was carried out to translate these solution results to organic films with the goal of translating to chemically modified beads. Polymer inclusion membranes (PIMs) based on celulose triacetate and trihexylphosphate or polyvinylchloride and octanol were prepared and investigated. Only modest enhancements in emission were noted, and the rigid confirmation of the receptor-fluorophore combination within the PIM may be at fault. The high selectivity exhibited by calix[4]crown-6 ethers towards the complexation of alkali metal ions has been exploited to synthesize a supramolecular fluorescent recognition agent capable of detecting both potassium and cesium ions in solution by PET.

The newly synthesized probe also behaves as an integrated logic gate combining an OR and a NAND gate for signal transduction. This is the first example of an integrated molecular logic device with feedback to the input of one logic element from the output of another.
http://www.osti.gov/em52/final_reports/60217.pdf

Performance Comparison: Direct-Push Wells Versus Drilled Wells [Fact Sheet]
Reeter, Chuck; Josh Fortenberry; Ernie Lory; Mark Kram, Naval Facilities Engineering Service Center, Port Hueneme, CA. Report No: TDS-2087-ENV; NTIS: ADA398555. 5 pp, Jul 2001

A comparison between ground-water monitoring alternatives (direct-push installed monitoring wells and drilled monitoring wells) is being conducted on the leading edge of a methyl tertiary butyl ether (MTBE) plume located in a shallow semi-perched aquifer (saturated thickness extending 9 to 22 feet (2.7 to 6.7 meters) below ground surface). The purpose of this effort is to determine whether direct-push wells compare favorably with conventional hollow stem auger (HAS) drilled wells. To make this determination, ground-water samples were extracted from numerous adjacent direct-push and HAS installed wells over several sampling events. Analysis of variance (ANOVA) statistical techniques were applied to the resulting chemical data to differentiate between the variability attributed to well type, temporal, and spatial factors.
http://handle.dtic.mil/100.2/ADA398555

Performance Comparison: Direct-Push Wells Versus Drilled Wells. Final Report
Kram, Mark (NFESC, Port Hueneme, CA), Dale Lorenzana; Joel Michaelsen (Univ. of California, Santa Barbara); Ernie Lory (NFESC). Report No: NFESC TR-2120-ENV, 182 pp, Jan 2001

A comparison between ground-water monitoring alternatives (direct-push installed monitoring wells and hollow stem auger drilled monitoring wells) was conducted on the leading edge of a methyl-tertiary butyl ether (MTBE) plume located at Naval Base Ventura County (NBVC) Port Hueneme, CA. The purpose of the effort was to determine whether representative chemical and water table data could be generated using properly designed direct-push monitoring wells. Field efforts included piezocone measurements, collection of core samples, pre-installation collection of water samples from selected depths, installation of customized monitoring well test cells, and sampling of the wells in triplicate. Laboratory efforts included chemical analysis of water samples (for MTBE and various inorganic materials and parameters), determination of permeability for selected core samples, and determination of grain size distribution for selected samples. No significant performance differences were observed between the direct-push wells and drilled wells. Within experimental error, the performance was comparable for the hydrogeologic setting of Port Hueneme. More specifically, the chemical variability among the different well types was less than that displayed by spatial heterogeneities associated with well screen depth differences and temporal variability. Although a comprehensive hydraulic evaluation was not conducted, water level values also appeared to yield comparable results for the different well designs. Since the study duration was limited to about six months, a longer observation period will be required to evaluate the long-term (greater than one year) performance of direct-push wells.
http://erb.nfesc.navy.mil/restoration/technologies/invest/access_tools/at-02.asp

PGNAA System for the Assay of RCRA Metals in Mixed Waste: A Review
Dulloo, Abdul R., Westinghouse Electric Company, LLC, Pittsburgh, PA. Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia. 8 pp, 2001

In Fiscal Year 1996, a performance test sponsored by DOE's Mixed Waste Focus Area was conducted to evaluate the capabilities of Prompt Gamma Neutron Activation Analysis (PGNAA) systems for the nondestructive assay (NDA) of RCRA metals. Up to that point, no practical NDA method had been demonstrated for the characterization of the hazardous components in mixed waste, though several techniques were being developed or already existed for the NDA of the radioactive components of mixed waste containers. The performance test was the first step of an effort to bridge this technology gap. A relatively mature technology that is typically employed for bulk analysis in areas such as in situ well logging, process control, and explosives detection, PGNAA is based on the detection of prompt gammas emitted as a result of neutron interactions with the constituent nuclei of the sample under analysis. The principal components of a conventional PGNAA system include a neutron source, a gamma-ray detector, nuclear signal-processing electronics, and hardware / software for gamma spectroscopy. The measurement campaign at ANL-West demonstrated the detection capabilities of PGNAA for mercury.
http://www.netl.doe.gov/publications/proceedings/01/indpartner/indpart01.html

Photochemical Changes in Cyanide Speciation in Drainage from a Precious Metal Ore Heap
Johnson, Craig A. (U.S. Geological Survey, Denver, CO); R.W. Leinz; D.J. Grimes; R.O. Rye.
Environmental Science & Technology, Vol 36 No 5, p 840-845, 2002

In drainage from an inactive ore heap at a former gold mine, the speciation of cyanide and the concentrations of several metals were found to follow diurnal cycles. At midday, environmentally significant concentrations of free cyanide were produced in a matter of minutes, causing trace copper, silver, and gold to be mobilized as cyanocomplexes from solids.

Portable Multi-Contaminant Detection Instrument for D&D
French, Patrick D.; Stuart P. Beaton, ADA Technologies, Inc., Littleton, CO. Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia. 8 pp, 2001

Under this three-Phase SBIR project, ADA Technologies is developing a portable, qualitative analysis device that can be maneuvered into difficult-to-access locations to determine the nature and levels of contamination prior to the initiation of D&D activities. The ADA tool will provide visual feedback via a miniature camera, elemental analysis of contaminants using laser-induced breakdown spectroscopy (LIBS), and radiation measurements using solid-state detectors. This novel technology will offer a "go/no-go" decision-making capability that in real time will allow the operator to analyze the nature, appearance, and type of contamination in a specific, difficult-to-access location. As envisioned, the proposed instrument will be contained in an instrument case of roughly 2.6 cubic feet. The sample probe will have an 8- to 16-foot semi-rigid umbilical to allow investigation of remote and difficult-to-access locations. The probe head will be less than 3.5" in diameter by 8" long, for easy access to the spaces of interest. Inside the probe head will be simple optics to focus an optical fiber-borne laser pulse for generation of a plasma, a color video camera, light source for visual inspection, radiation detector, and a second optical fiber for plasma-emission transmission to the instrument. The head will have a quick-disconnect from the umbilical to allow easy replacement of the protective shroud and/or disposal of contaminated components. One innovative aspect of this instrument will be the combination of fixed and variable band-span (automated) spectrographs to allow the instrument to quickly identify contaminants that are present and to then refine the determination in subsequent laser pulses. Under the Phase I project, an ADA Technologies' LIBS instrument (previously developed) was enhanced with a small video camera in the sample wand, and the instrument was tested to determine the detection limit for many contaminants anticipated at D&D sites or other clean-up sites, such as Superfund sites. In Phase II, ADA will complete the design and field-testing/validation of this new instrument by

developing several application-specific sample probes, integrating radiation sensors, refining user-appropriate software, field evaluation, and modifying/optimizing the instrument based on the field evaluation feedback.
http://www.netl.doe.gov/publications/proceedings/01/indpartner/indpart01.html

A Potentiometric Detector for Hydrogen Cyanide Gas Using Silver Dicyano Complex
Rao, V. Kameswara (Defence Research and Development Establishment, Gwalior, India), S. Suresh, A. Bhattacharya, N.B.S.N. Rao. Talanta, Vol 49 No 2, p 367-371, 1999

A sensitive method for detecting hydrogen cyanide gas in atmosphere at its TLV makes use of two silver electrodes kept in two separate compartments that are in contact with a solution of constant concentration of silver dicyano complex at a pH 11.5. The reference electrode is concealed and the sensing electrode is exposed to the incoming air. In the absence of hydrogen cyanide gas, the potential difference between the two electrodes is zero, but when hydrogen cyanide gas enters the cell, the activity of Ag+ ions nearer to the sensing electrode changes, thereby generating a potential difference between the two electrodes. The minimum detectable limit is 0.66 mg/m^3. The various concentrations of silver dicyano complex used gave similar plots.

A Practical Approach to Site Characterization of a Contaminated Fractured Bedrock Aquifer Using Geophysical Techniques
Hoak, Andrew T., Marin Environmental, Inc., Richmond, VT. Geological Society of America Northeastern Section, 37th Annual Meeting, 25-27 March 2002, Springfield, Massachusetts

A 1994 borehole geophysical survey of a subsurface gasoline release in Vermont included single point resistance, fluid temperature, spontaneous potential, and heat-pulse flow meter measurements that identified significant fractures between 87-187 and 335-395 feet below ground surface (bgs) and indicated a general downward migration of ground water to a depth of approximately 340-400 feet bgs at a rate up to 0.15 gpm. Although gasoline-compound concentrations in the well have decreased substantially since remedial efforts began, they remain significantly above Vermont drinking-water standards. A supplemental geophysical investigation (a fracture trace analysis and electrical resistivity survey) performed in 1999 confirmed the general north-south orientation of fractures and the intersection of at least two fractures in the vicinity of the contaminated supply well.

Practical Geophysical Applications for Everyday Operational and Engineering Problems at Newmont Gold Company
Freeman, K.; J. Wright; N. Phillips. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 23-26 March 1997, Reno, Nevada. p 53-56, 1997

This paper presents an example of monitoring for leaks in a tailings pond by combining a mise-a-la-masse source in the pond with permanent electrode arrays under its liner.

Principles for Measurement of Chemical Exposure Based on Recognition-Driven Anchoring Transitions in Liquid Crystals
Shah, Rahul R.; Nicholas L. Abbott. Science 2001, Vol 293, p 1296-1299, 17 Aug 2001

Researchers have created a small sensor that can be worn like a badge to monitor the environment for harmful vapors at parts-per-billion concentration levels. The sensors can detect putrescine and cadaverine, the smelly compounds produced by spoiled fish and meat, pesticides such as diazinon and parathion, and nerve gases such as sarin. The new sensor consists of an ultra-thin layer of gold film with nanoscale corrugation. The surface is coated with protruding chemical receptors that weakly bond to a liquid crystal. When exposed to the specific chemical selected for detection, the receptors bond more strongly with that target chemical than they do with the liquid crystal, which forces the liquid crystal into a new orientation that is controlled by the underlying surface texture. The new orientation is apparent to the naked eye as a change in the sensor's color or brightness. The sensor returns to its original colour after being distanced from the targeted chemical. The sensor surfaces can be designed for an instantaneous response upon exposure, or they can be designed to measure cumulative exposure over time. By pairing particular liquid crystals and receptors with specific chemical properties, the sensors can be tailored to detect specific compounds. Multiple receptor liquid crystal combinations on the sensor's surface enable simultaneous detection of several different chemicals. Each liquid crystal is likely to cost less than $1.

Problemsolvers: Electronic Eye Spots Underground Leak
Industrial Wastewater, Vol 9 No 3, May/Jun 2001

Following a spill at a fuel depot, workers needed to determine where the fuel was entering the local storm water system before they could begin to clean up the site. The response team used a video inspection system manufactured by Pearpoint Inc. of Thousand Oaks, CA, to track the fuel to the infiltration point and pinpoint the location for remediation.

Prototype Detector Could Identify Anthrax Quickly: New Technique Requires Only a Few Minutes of FAME
Sandia National Laboratories News Release, 6 Mar 2002

A prototype handheld detector under development at Sandia National Laboratories can identify the fatty acid methyl esters (FAME) of anthrax in less than five minutes. Identification of the bacillus in minutes, rather than the hours currently necessary, is a crucial step in alerting a building's occupants to evacuate, as well as in activating defenses such as anti-anthrax foam dispersal systems. The detector (a patent application has been submitted) would also aid security people making their rounds to locate point sources of the disease. The technique works by preconcentrating airborne particles on a tiny hotplate that acts like a skillet on a stove. The hotplate immediately vaporizes the fatty acids in anthrax's cell walls to create the FAME that form a unique fingerprint of the bacterium. A small computer program correlates the amount of mass of each ester emitted in the analyzed gases at particular times—a process called elution—with already categorized elution peaks indicative of anthrax or other diseases. Pyrolization is not only far faster than current suitcase-sized prototype devices but requires considerably less power—150 milliwatts instead of 130 watts. The extremely low power is made possible by microdevices fabricated at Sandia. Components of the device have been individually tested, though not yet linked with a commercially available aerosol collector. Sandia's chemographic and surface acoustic wave analysis of gases driven from Anthrax bacteria enables far more rapid identification.

Pulsed Fast / Thermal Neutron Analysis: a Technique for Explosives Detection
Vourvopoulosa, G.; P.C. Womble, Applied Physics Inst., Western Kentucky Univ., Bowling Green.
Talanta, Vol 54 No 3, p 459-468, 2001

Pulsed fast/thermal neutron analysis (PFTNA) is a neutron-based technique in which reactions can identify and quantify a large number of elements. The elements emit characteristic Y-rays that are the 'fingerprints' of each isotope. This technique is being employed in a variety of applications: bulk coal analysis, contraband detection, and detection of explosives.

PVC Membrane Ion Selective Electrode for the Determination of Pentachlorophenol in Water, Wood and Soil Using Tetrazolium Pentachlorophenolate
Abbas, M.N.; G.A.E. Mostafa; A.M.A. Homoda, Microanalytical Laboratory, Department of Applied Organic Chemistry, National Research Center, Dokki, Cairo , Egypt. Talanta, Vol 55 No 3, p 647-656, 2001

A novel PVC membrane electrode selective for the pentachlorophenol (PCP) ion is based on a 2,3,5-triphenyl-2H-tetrazolium (TPT) pentachlorophenolate ion pair as an electroactive material. An average recovery of 96.2% with relative standard deviation of 2.3% has been achieved for the determination of 75.0 ppm PCP in wastewater samples.

Quantification of Microbial Sulfate Reduction in a Petroleum-Contaminated Aquifer
Schroth, M.H.; J. Kleikemper; C. Bolliger; J. Zeyer, Inst. of Terrestrial Ecology/Soil Biology, Swiss Federal Inst. of Technology. European Geophysical Society (EGS) XXV General Assembly, 25-29 April 2000, Nice, France. Geophysical Research Abstracts, CD-ROM, Volume 2, 2000

A study was undertaken to evaluate the feasibility of the single-well push-pull test (PPT) method, coupled with stable sulfur isotope analysis, for the quantification of rates of microbially mediated sulfate reduction in a PHC-contaminated aquifer. Several field PPTs performed in an aquifer affected by petroleum hydrocarbons involved the injection of anoxic test solutions (500 to 1000 L per test) containing bromide as conservative tracer and 1 mM sulfate as reactant into the aquifer via an existing monitoring well. After a rest phase of 43 to 68 h, the test solution/ground-water mixture was pulled from the same location, and concentrations of bromide, sulfate, sulfide, and sulfur isotope ratios from extracted sulfate were measured. Results indicated sulfate reduction activity in the vicinity of the test well. Isotopic fractionation of sulfate (22.8 ± 3.4) also provided strong evidence for microbially mediated sulfate reduction.

Rational Materials Design of Sorbent Coatings for Explosives: Applications with Chemical Sensors
Houser, Eric J. (Naval Research Laboratory, Washington, DC); Todd E. Mlsna (Geo-Centers, Inc., Rockville, MD), Viet K. Nguyen, Russell Chung; Robert L. Mowery (Naval Research Laboratory, Washington, DC), R. Andrew McGilla. Talanta, Vol 54 No 3, p 469-485, 2001

A series of chemoselective polymers have been designed and synthesized to enhance the sorption properties of polymer-coated chemical sensors for polynitroaromatic analytes. A polynitroaromatic vapor bed was used to test polymer-coated surface acoustic wave (SAW) devices with different explosive vapors. Dinitrotoluene detection limits fell in the <100 parts per trillion ranges.

Remote Electrochemical Sensor for Multicomponent Monitoring. Technical Completion Report
Wang, Joseph, New Mexico State Univ., Las Cruces. New Mexico Waste-Management Education and Research Consortium (WERC) in cooperation with U.S. DOE. 11 pp, Feb 1999

This research has addressed the urgent needs for providing timely analytical data on priority inorganic and organic pollutants through the development of remote electrochemical sensors. The new devices rely on the novel and judicious adaptation of modern electroanalytical techniques to a submersible

operation, and provides a fast return of the analytical information in a timely, safe and cost effective fashion. This paper reports on a new renewable-reagent probe for adsorptive stripping measurements based on continuous internal delivery of the complexing ligand on a newly compact sensor configuration for remote monitoring of trace mercury on a submersible probe that internally addresses errors common to trace metal monitoring, and a new remote sensor for in situ biosensing of enzyme inhibitors (e.g., cyanide). The new devices are characterized with remarkable sensitivity, ppb detection limits, high stability, and simplicity. The new probes should revolutionize the way of monitoring priority pollutants.
http://www.werc.net/researchers/pdf/wang99.pdf

Remote Mapping of Mine Wastes
Paterson, Norman. Proceedings of Exploration '97, Fourth Decennial International Conference on Mineral Exploration: Prospectors and Developers Association of Canada, Toronto, ON. p 905-916, 1997

This paper presents a useful overview of geophysical methods, including spectral remote sensing techniques, for detecting mine waste. It contains several case studies from Canada, evaluations of lessons learned, and a good bibliography. It offers two particularly instructive examples involving repeat geophysical surveys to monitor the evolution of plumes. The first, made with an EM-34 system, indicated a new lobe of the plume that had developed between surveys. The second example shows the GPR profiles reproduced as figures. The paper also reports an attempt to trace an acid mine drainage (AMD) plume using self potential (SP), though the results were strongly affected by near-surface conditions and were inconclusive.

Residual Hydrocarbons in a Water-Saturated Medium: a Detection Strategy Using Ground Penetrating Radar
Kim, Changryol; Jeffrey J. Daniels; Erich D. Guy; Stanley J. Radzevicius; Jennifer Holt. Environmental Geosciences, Vol 7 No 4, p 169-176, Dec 2000

A tank model filled with gravel and sand was designed to allow ground-penetrating radar (GPR) measurements to be made on the surface before, during, and after water and gasoline injections and fluctuations within the tank. Background GPR measurements were made initially with only water being raised and lowered in the model, and the water table was then raised and lowered beneath a volume of 219 liters of gasoline that was injected into the bottom of the tank. Measurements from the initial raising and lowering of the water with no gasoline present demonstrate the sensitivity of GPR for monitoring changes in subsurface water content and minor fluctuations of the water table. Measurements made during the raising and lowering of the water table with gasoline in the model show differences from the measurements made when only water was raised and lowered, and a comparison of the data show that reflections in GPR data can be enhanced when residual gasoline is present in a water-saturated system because there is less attenuation of the radar signal. Differences in travel times to subsurface reflections between the two stages of the experiment are also caused by the residual gasoline present in the water-saturated medium. Results of this study provide the basis for a strategy that has the potential for successful detection and delineation of LNAPL-contaminated areas at field sites where the conditions are similar to those modeled in the experiment.

Resistivity Imaging of a Partially Reclaimed Coal Tailings Pile
Painter, M.A.; B. Laverty; M.W. Stoertz; D.H. Green. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 20-24 February 2000, Arlington, Virginia. p 679-687, 2000

A dipole-dipole resistivity survey did an excellent job of outlining the bottom of a coal tailings pile in southern Ohio. Coal tailings with acid mine drainage (AMD) had resistivity of <20 ohm-m, unconsolidated clays, silts, and sands fell in the range 20 to 50 ohm-m, and sandstone bedrock was >50 ohm-m.

Results of Tank-Leak Detection Demonstration Using Geophysical Techniques at the Hanford Mock Tank Site--Fiscal Year 2001
Barnett, D.B.; G.W. Gee; M.D. Sweeney, Pacific Northwest National Lab., Richland, WA. Report No: PNNL-13818, 231 pp, Mar 2002

The following five geophysical leak-detection technologies were demonstrated in 2001 at the Hanford Site Mock Tank: electrical resistivity tomography (ERT), cross-borehole electromagnetic induction (CEMI), high-resolution resistivity-steel casing resistivity technology (HRR-SCRT), cross-borehole radar (XBR), and cross-borehole seismic tomography (XBS). The Mock Tank was built in 1995 to test the applicability and effectiveness of ERT imaging of simulated fluid leaks beneath a steel-lined tank. A 36-wt% solution of sodium thiosulfate pentahydrate (a benign waste surrogate) was released to a central leak point in the Mock Tank at different discharge rates during five leak periods. A total of ~4,000 gallons of solution was released during the two-week test period. All geophysical methods required the monitoring of background and noise conditions before the solution (leak) detection portions of the test. Two of the five solution releases were "blind" in that none of the operators knew the solution release volumes/flowrates. ERT and HRR-SCRT were the only geophysical methods of the five tested that produced estimates of volumes leaked during these releases. The XBR method was able to detect a leak after ~100 gallons were released but did not produce leak-volume estimates. Qualitative estimates based on the FY 2001 results of the ERT method indicate that the minimum detectable leak for the most robust configuration of the method (16 vertical electrode arrays around the tank with tomographic imaging) is in the range of hundreds of gallons. The 3-D tomographic method also allowed approximations of leak location, size, and movement. Results of CEMI deployment were only marginally successful in identifying a developing leak beneath the tank. Changes in soil resistivity between background conditions and post-solution release periods suggest that leaks were detected, but other conditions (such as unplanned leaks in peripheral wells) distorted the data. Four electrode configurations (central-leak-point electrode to surface electrodes, steel well casing to surface electrodes, tank to pseudo-casings ["short-circuited" ERT arrays], and surface electrode to pseudo-casings) deployed using the HRR-SCRT methods detected leakage from the Mock Tank. It was estimated that the minimum leak volume detectable using the most robust configuration (SCRT, mise-a-la-masse configuration) is less than 10 gallons at the nearby Sisson and Lu site and ~500 gallons for measurements between steel casings and surface electrodes (HRR method) at the Mock Tank. Because of the potential of leaking borehole casings interfering with other methods, the XBS method was not adequately tested but still provided structural (stratigraphic, textural) constraints and appeared to respond to the introduction of the leak qualitatively. The XBR method apparently was capable of detecting relatively small releases ~100 gallons, and extraneous electrical wires in the PVC boreholes did not degrade the signal where it was deployed. The ERT and HRR-SCRT methods were selected for further testing and demonstration.
http://vadose.pnl.gov/tldd_rpts.stm

The Role of Laser Gas Detection in Alberta's Environmental Initiatives
Adam, Hamish; John Tulip, Boreal Laser Inc., Edmonton, Alberta. Petroleum Technology Alliance of Canada (PTAC), Calgary, Alberta, Canada. Presentation made 14 Apr 2000

Boreal Laser Inc. and Alberta Environmental Protection sponsored a Technology Information Session regarding laser-based gas detection. Boreal's patents concern the use of tunable diode lasers (TDLs) to measure gases. The properties of TDLs enable new kinds of gas detection and measurement. Boreal's GasFinder determines the amount of gas between the laser source and a retroreflector. The laser is tuned to a unique absorption line for each gas, thus avoiding interference from other gases. GasFinders are now available for HF, H2S, HCN, NH3, C2H4, and the greenhouse gases, CO2, CH4, and N2O. Accuracy is assured by a permanent on-board reference cell, its calibration traceable to NIST standards. Typical detection limits are in the 1 ppb to 1 ppm range over paths of 1 to 1,000 meters, with response times of a few seconds; however, successful applications have included one requiring a path length of 0.38 meter and another requiring five responses per second. Because GasFinder is small, light (5 kg) and permanently calibrated, it typically takes less than ten minutes to set it up and begin measuring gases. The software is user-friendly. Alignment is easy and stable. Response does not depend on path length, so a series of different paths can be measured in quick succession. This unique combination of features has enabled GasFinder's use in measuring fugitive emissions and as a permanent monitor in a variety of industries. The presentation included results from three installations that rely on the technology for detection of trace gases: H2S leak sources in a heavy oil upgrader, airborne detection of CH4 leaks from natural gas pipelines, and measurement of CH4 emissions from gas compressor stations. To jurisdictions that have expressed concern over ammonia and ethylene emissions and the roles of these gases in smog formation and other health effects, GasFinder offers a means to monitor these gases in-process, in-plant, and at the fenceline. PTAC makes no representation regarding ownership or quality of the subject technology. Contact: Hamish Adam, Boreal Laser Inc., (403) 271-2007, hadam@boreal-laser.com.

Sandia's Soil and Groundwater Chemical 'Sniffer' May Help Protect the Nation's Water Supply

Sandia National Laboratories News Release, 3 Oct 2001

DOE’s Sandia National Laboratory has developed a real-time gas- and water-quality monitoring system that consists of a miniature sensor array packaged in a weatherproof housing. The electronic sniffer can be put directly underground in ground water or soils where the humidity reaches nearly 100% and left at the site for in situ detection of toxic chemicals. It will be able to monitor chemical spills, leaking underground storage tanks, and chemical waste dumps. If the sensor is emplaced for long-term monitoring, it will send back chemical readings to a data collection station where information will be downloaded and analyzed. Telemetry methods can also transmit data wirelessly from remote stations to a computer that uploads information to an interactive web site, providing immediate access to authorized individuals anywhere in the country. The heart of the device is an array of differing miniature sensors that can detect volatile organic compounds (VOCs). Each polymer-absorption sensor (called a chemiresistor) is fabricated by mixing a commercial polymer dissolved in a solvent with conductive carbon particles. The ink-like fluid is deposited and dried on wire-like electrodes on a specially designed microfabricated circuit. When VOCs are present, the chemicals absorb into the polymers, causing them to swell. The swelling changes the electrical resistance that can then be measured and recorded. The amount of swelling corresponds to the concentration of the chemical vapor in contact with the polymers. The polymers will shrink once the chemical is removed, reverting the resistance to its original state. The researchers believe that by using four different kinds of polymers—one for each sensor—they can detect all solvents of interest. The array of differing sensors can be used to identify different VOCs by comparing the resulting chemical signatures with those of known samples. The rugged, waterproof packaging design allows the device to be placed in water or underground. The package surrounding the chemiresistor chip is small, about three centimeters in diameter, and allows the chemiresistors to be exposed to VOCs in both aqueous and gas phases. Recent versions of the housing have been constructed of stainless steel. The package is modular, like a water-tight flashlight. It can be unscrewed, allowing for easy exchange of components.

A unique feature of the packaging is that it has a small "window" covered by a GORE-TEX membrane to maintain a waterproof seal. Like clothing made of GORE-TEX, it repels liquid water but "breathes," allowing vapors to diffuse across the membrane. If the device is immersed in contaminated water, VOCs dissolved in the water will partition across the membrane into the gas phase, where they are detected by the chemiresistors. Inside the packaging the chemiresistors are placed on a 16-pin dual inline package connected to a long weatherproof cable. The cable then can be connected to any data logger. Since only DC measurements are being made, the cable can be almost any length. Future tests are planned at Edwards Air Force Base and the Nevada Test Site. Underground storage tank monitoring—there are over 2 million of them in the U.S.—is a potential market for the new sensor. Technical contacts: Cliff Ho, (505) 844-2384, ckho@sandia.gov; or Bob Hughes, (505) 844-8172, rchughe@sandia.gov.

Screen-Printed Electrode Based on AChE for the Detection of Pesticides in Presence of Organic Solvents

Andreescu, Silvana (Univ. de Perpignan, Perpignan Cedex, France), Thierry Noguer; Vasile Magearu (Univ. of Bucharest, Bucharest , Romania); Jean-Louis Marty (Univ. de Perpignan, Perpignan Cedex, France). Talanta, Vol 57 No 1, p 169-176, 2002

A screen-printed biosensor for the detection of pesticides in water in the presence of miscible organic solvents is based on the use of p-aminophenyl acetate as an acetylcholinesterase substrate. The acetylcholinesterase (AChE) is immobilized on a screen-printed electrode surface by entrapment in a PVA-SbQ polymer. The sensor shows good sensitivity in experiments with concentrations of organic solvents below 10%. Detection limits as low as 1.9110-8 M paraoxon and 1.2410-9 M chlorpyrifos ethyl oxon were obtained when experiments are carried out in 5% acetonitrile.

Seismic Surface Wave Tomography of Waste Sites

Long, Leland Timothy, Georgia Inst. of Technology, School of Earth and Atmospheric Sciences, Atlanta, GA. U.S. DOE Grant Project G-35-W02, Final Report [55218]. 22 pp, 2001

Because Rayleigh waves generally have the largest amplitude of all waves generated by a vertical surface impact and because the near-surface shear-wave velocity primarily determines the Rayleigh wave velocity, Rayleigh waves may be used to image shallow shear-wave structures. The Rayleigh wave group velocity can be measured from records of surface waves that have traversed a study area, typically, with a surface source on one side and an array of geophones along the opposite side. After data processing and noise suppression, group-velocity travel times from different source and receiver locations can be used in a tomographic inversion to image the distribution of group velocity within the study area, then vertical shear-wave velocity structure at any point can be interpreted from its dispersion curve. The objective of this study was to develop analysis programs for surface-wave group-velocity tomography and apply them to three test areas. Data were obtained from two square areas each 30 meters on a side, and one that was 16 meters on a side, in addition to processing data from the Oak Ridge National Laboratory site. At all sites, usable group velocities were obtained for frequencies from 16 to 50 Hz using a sledgehammer source. The resulting tomographic images and velocity anomalies were sufficient to delineate suspected burial trenches (one 4 meters deep) and anomalous velocity structure related to rocks and disturbed soil. The success was not uniform because in portions of one area the inversion for shear-wave structure became unstable. More research is needed to establish a more robust inversion technique.
http://www.osti.gov/em52/final_reports/55218.pdf

Self-Assembled and Self-Sorted Array of Chemically Active Beads for Analytical and Biochemical Screening

Andersson, Helene; Christina Jonsson; Christina Moberg; Goran Stemme, Royal Inst. of Technology, Stockholm , Sweden. Talanta, Vol 56 No 2, p 301-308, 2002

A general screening platform consisting of dots of immobilized beads on silicon has been developed via self-sorting and self-assembly of different kinds of beads. The dots are defined by a teflon-like film, the hydrophobic characteristics of which prevent liquid cross-contamination. The individual dots can identify different target molecules simultaneously due to a new way of microcontact printing in which different target solutions are printed in parallel using one stamp. Streptavidin-, amino-, and hydroxy-functionalized beads have been self-sorted and self-assembled on both separate and common platforms. The self-sorting and self-arrangement are based on surface chemistry only.

Simultaneous Spectrophotometric Determination of Cyanide and Thiocyanate after Separation on a Melamine-Formaldehyde Resin
Gumus, Gulcin; Birsen Demirata; Resat Apak, Istanbul Technical Univ., Maslak, Istanbul, Turkey.
Talanta, Vol 53 No 2, p 305-315, 2000

A simple indirect spectrophotometric method for the determination of cyanide is based on the oxidation of the cyanide with chlorine. A color reaction with o-tolidine (3,3'-dimethylbenzidine) determines the residual chlorine. The developed method is relatively inexpensive, less laborious than the standard (Spectroquant) procedure, and insensitive to the common interferent, cyanate.

Soil Gas Sampling Technology: Quadrel Services, Inc. EMFLUX® Soil Gas Investigation System. Innovative Technology Verification Report
Tetra Tech EM Inc., San Diego, CA. Report No: EPA/600/R-98/096, 72 pp, Aug 1998

The EMFLUX® system is a passive soil gas sampling system that predicts periods of maximum soil gas emissions in order to select optimal sampling times. EMFLUX® allows simultaneous sample collection by multiple field collectors, eliminating the movement of equipment. The system consists of cartridges, insertion tools, and sample analysis and computer modeling. The EMFLUX® cartridge consists of a sorbent sealed in a fine mesh screen, which is placed in a glass vile for sample collection and shipped for analysis. The system was demonstrated in 1997 at two sites: the Small Business Administration (SBA) site in Albert City, IA, and the Chemical Sales Company (CSC) site in Denver, CO. These sites have a wide range of volatile organic compound concentrations, and each has a distinct soil type. The EMFLUX® system was compared to a reference method—active soil gas sampling—in terms of VOC detection and quantitation, sample retrieval time, and cost. The demonstration data indicated the following performance characteristics: The EMFLUX® system detected the same compounds as the reference method, as well as several VOCs that the reference method did not detect. VOC concentrations detected by the system were typically one to four orders of magnitude lower than those reported by the reference method. The sample retrieval times were generally quicker using EMFLUX® than the reference method in the clay soils at the SBA site, but slower than the reference method in the sandy soils at the CSC site. The EMFLUX® field collectors were left in place for four days at each site and required twelve days at the SBA site and sixteen days at the CSC site for analysis. The system cost $85 to $195 per sample plus equipment costs plus mobilization/demobilization costs. Operating costs ranged from $660 to $1,390 at the clay soil site and $710 to $1,440 at the sandy soil site.
http://www.epa.gov/ORD/SITE/reports/138.htm

Soil Gas Sampling Technology: W.L. Gore & Associates GORE-SORBER® Screening Survey. Innovative Technology Verification Report
Tetra Tech EM Inc., San Diego, CA. Report No: EPA/600/R-98/095, 68 pp, Aug 1998

The GORE-SORBER® module is a passive soil gas sampler that consists of several separate collection units called sorbers. Each sorber contains sorbent materials selected for their broad range of volatile

organic compounds and semivolatile organic compounds and for their hydrophobic characteristics. The sorbers are sheathed in a vapor-permeable insertion and retrieval cord constructed of inert, hydrophobic material that allows vapors to move freely across the membrane and onto the sorbent material and that protects the granular adsorbents from physical contact with soil particulates and water. The GORE-SORBER® module was demonstrated in 1997 at two sites: the Small Business Administration (SBA) site in Albert City, IA, and the Chemical Sales Company (CSC) site in Denver, CO. The sites have a wide range of volatile organic compound concentrations, and each has a distinct soil type. The GORE-SORBER® Screening Survey was compared to a reference method, active soil gas sampling, in terms of VOC detection and quantitation, sample retrieval time, and cost. The GORE-SORBER® Screening Survey detected the same compounds as the reference method, as well as several VOCs that the reference method did not detect. At high contamination levels, the ratio between the mass of contaminant in soil gas detected using the test module and the concentration of contaminant in soil gas detected using the reference method decreases. The GORE-SORBER® modules sample retrieval times were quicker than the reference soil gas sampling method in clay soils at the SBA site and slower in the sandy soils at the CSC site. The modules were left in place for ten days at each site and required an average of sixteen days per site for analysis. The GORE-SORBER® Screening Survey cost $125 to $225 per sample plus equipment costs plus mobilization/demobilization costs. Operating costs ranged from $810 to $1540 at both the clay soil site and the sandy site. A site-specific cost and performance analysis is recommended before selecting a subsurface soil sampling method because with any technology selection, the user must determine what is appropriate for the application and project data quality.
http://www.epa.gov/ORD/SITE/reports/139.htm

Soil Sampling Technology: Art's Manufacturing and Supply AMS™ Dual Tube Liner Sampler. Innovative Technology Verification Report
Tetra Tech EM Inc., San Diego, CA. Report No: EPA/600/R-98/093, 110 pp, Aug 1998

The Dual Tube Liner Sampler is a soil sampling tool capable of collecting unconsolidated subsurface material to depths that depend on the capability of the advancement platform. The Dual Tube Liner Sampler is advanced into the subsurface with a direct-push platform. The sampler was demonstrated in 1997 at two sites: the Small Business Administration (SBA) site in Albert City, IA, and the Chemical Sales Company (CSC) site in Denver, CO. These sites contain a wide range of volatile organic compound concentrations, and each has a distinct soil type. The Dual Tube Liner Sampler was compared to a reference method (hollow-stem auger drilling and split-spoon sampling) in terms of sample recovery, VOC concentrations in recovered samples, sample integrity, reliability and throughput, and cost. Average sample recoveries for the Dual Tube Liner Sampler were higher in clay soil and lower in sandy soil. There was a statistical difference between the VOC concentrations for one of the twelve Dual Tube Liner Sampler and reference sample method pairs at the SBA site and for three of the thirteen pairs at the CSC site. The integrity of the lined chamber of the Large-Bore Soil Sampler was not preserved when the sampler was advanced through highly contaminated soils. The Dual Tube Liner Sampler reliability to collect a sample in the first attempt was higher than that of the reference sampling method in both clay and sandy soils. The average retrieval time for the Dual Tube Liner Sampler was quicker then the reference method in clay soil but slower in sandy soil. The Dual Tube Liner Sampler costs for both clay soil and sandy soil sites were lower than the reference sampling method. The cost depends on the amount of samples required, the sample retrieval time, soil type, sample depth, and the disposal costs associated with drill cuttings.
http://www.epa.gov/ORD/SITE/reports/134.htm

Soil Sampling Technology: Clements Associates, Inc., JMC Environmentalist's Subsoil Probe. Innovative Technology Verification Report

Tetra Tech EM Inc., San Diego, CA. Report No: EPA/600/R-98/091, 110 pp, Aug 1998

The Environmentalist's Subsoil Probe (ESP) is a sampling tool for collecting unconsolidated subsurface material at depths that depend on the capacity of the advancement platform. The ESP can be advanced into the subsurface with direct-push platforms, drill rigs, or manual methods. The ESP was demonstrated in 1997 at two sites: the Small Business Administration (SBA) site in Albert City, IA, and the Chemical Sales Company (CSC) site in Denver, CO. The two sites contain a wide range of volatile organic compound concentrations, and each has a distinct soil type. The ESP was compared to a reference subsurface soil sampling method (the hollow-stem auger drilling and split-spoon sampling) in terms of sample recovery, VOC concentrations in recovered samples, sample integrity, reliability and throughput, and cost. Compared to the hollow-stem auger drilling and split-spoon soil sampling method, average sample recoveries for the ESP were higher for both the clay and sandy soils tested. A statistical difference between the VOC concentrations measured was detected for one of the seven ESP and reference sampling method pairs collected at the SBA site and for one of the eleven sampling pairs collected at the CSC site. The data also suggest that the reference sampling method tends to yield higher results than the ESP in sampling fine-grained soils. In two of the twelve integrity test samples, the integrity of a lined chamber of the ESP was not preserved when the sampler was advanced through highly contaminated clay soils. In the first attempt, the reliability of ESP to collect a sample was higher than that of the reference sampling method in both clay and sandy soils. When using two operators, the average sample retrieval time for the ESP was quicker than the retrieval time for the reference method in clay soil but slower in sandy soil. The costs for collecting soil samples using the ESP was lower than the reference sampling method for both clay soil and sandy soil sites. The cost depends on the amount of samples required, the sample retrieval time, soil type, soils depth, and the disposal costs associated with drill cuttings.
http://www.epa.gov/ORD/SITE/reports/135.htm

Soil Sampling Technology: Geoprobe® Systems, Inc. Large Bore Soil Sampler. Innovative Technology Verification Report
Tetra Tech EM Inc., San Diego, CA. Report No: EPA/600/R-98/092, 113 pp, Aug 1998

The Large-Bore Soil Sampler is a sampling tool for collecting unconsolidated subsurface material at depths that depend on the capability of the advancement platform. The Large-Bore Soil Sampler can be advanced into the subsurface with direct-push platforms, drill rigs, or manual methods. The sampler was demonstrated in 1997 at two sites: the Small Business Administration (SBA) site in Albert City, IA, and the Chemical Sales Company (CSC) site in Denver, CO. These sites contain a wide range of volatile organic compound concentrations, and each has a distinct soil type. The Large-Bore Soil Sampler was compared to a reference method (hollow-stem auger drilling and split-spoon sampling) in terms of sample recovery, VOC concentrations in recovered samples, sample integrity, reliability and throughput, and cost. Average sample recoveries for the Large-Bore Soil Sampler were higher in clay soil and lower in sandy soil. There was a statistical difference between the VOC concentrations for one of twelve Large-Bore Soil Sampler and reference sample method pairs at the SBA site and for two of eleven pairs at the CSC site. The reference method tends to yield higher concentrations than the Large-Bore Soil Sampler in sampling coarse-grained soils. The integrity of the lined chamber of the Large-Bore Soil Sampler was not preserved when the sampler was advanced through highly contaminated soils. The Large-Bore Soil Samplers' reliability to collect a sample in the first attempt was higher than that of the reference sampling method in both clay and sandy soils. The Large-Bore Soil Sampler costs for both clay soil and sandy soil sites were lower than the reference method. The cost depends on the amount of samples required, the sample retrieval time, soil type, soils depth, and the disposal costs associated with drill cuttings.
http://www.epa.gov/ORD/SITE/reports/136.htm

Soil Sampling Technology: Simulprobe® Technologies, Inc. Core Barrel Sampler. Innovative Technology Verification Report
Tetra Tech EM Inc., San Diego, CA. Report No: EPA/600/R-98/094, 109 pp, Aug 1998

The Core Barrel Sampler is a soil sampling tool capable of collecting unconsolidated subsurface material to depths that depend on the capability of the advancement platform. The Core Barrel Sampler can be advanced into the subsurface with direct-push platforms, drill rigs, or manual methods. The sampler was demonstrated in 1997 at two sites: the Small Business Administration (SBA) site in Albert City, IA, and the Chemical Sales Company (CSC) site in Denver, CO. These sites contain a wide range of volatile organic compound concentrations, and each has a distinct soil type. The Core Barrel Sampler was compared to a reference method (hollow-stem auger drilling and split-spoon sampling) in terms of sample recovery, VOC concentrations in recovered samples, sample integrity, reliability and throughput, and cost. Average sample recoveries for the Core Barrel Sampler were higher in clay soil and lower in sandy soil. There was a statistical difference between the VOC concentrations for two of the twelve Core Barrel Sampler and reference sample method pairs at the CSC site. The integrity of the unlined chamber of the Core Barrel Sampler was not preserved, in eight of the 14 integrity tests, when the sampler was advanced through highly contaminated soils. The Core Barrel Sampler's reliability to collect a sample in the first attempt was lower than that of the reference sampling method in both clay and sandy soils. The average retrieval time for the sampler was quicker then the reference method in clay soil but slower in sandy soil. Costs for both clay soil and sandy soil sites were lower than the reference sampling method. The cost depends on the number of samples required, the sample retrieval time, soil type, sample depth, and the disposal costs associated with drill cuttings. A site-specific cost and performance analysis is recommended before selecting a subsurface soil sampling method because with any technology selection, the user must determine what is appropriate for the application and project data quality.
http://www.epa.gov/ORD/SITE/reports/137.htm

Solvent Vapour Monitoring in Work Space by Solid Phase Micro Extraction
Li, K. (Environment Canada, Ottawa, Ont., Canada); A. Santilli; M. Goldthorp; S. Whiticar; P. Lambert; M. Fingas. Journal of Hazardous Materials, Vol 83 No 1-2, p 83-91, 2001

Solid-phase micro-extraction (SPME) was compared to the active sampling technique in a typical lab atmosphere. A mixed-phase carboxen/ polydimethylsiloxane (PDMS) fiber was found to be suitable for VOC work at ambient concentration. The sensitivity of SPME was far greater than the charcoal sorbent tube method. Adsorption characteristics and calibration procedures were studied. An actual application of SPME was carried out to measure background level of solvent vapor (DCM). Agreement between the SPME and the charcoal sampling method was generally within a factor of two.

Sonic CPT Probing in Support of DNAPL Characterization
Gildea, Martin L.; J.W. Haas; S.P. Farrington; D.E. Chitty; W.L. Bratton, Applied Research Associates, Inc., South Royalton, VT. Report No: ARA-4717, NTIS: ADA384783. 104 pp, Nov 2000

Cone Penetrometer Technology (CPT) offers numerous advantages in subsurface characterization in that it is generally faster, less expensive, safer, and generates far less secondary waste than conventional drilling methods. DoD and DOE efforts are supporting the development of advanced sensors for delivery by the cone penetrometer. To accommodate these new sensors, probe sizes have increased (from 1.44-in OD to 1.75-in OD and currently to 2.25-in OD) and the ability of CPT to reach desired depths has been increased. To enhance the penetration capability of the CPT, a sonic vibratory system was integrated with conventional CPT to advance cone penetrometer sensor packages past currently attainable depths. This CPT enhancement provides an efficient tool for hazardous waste

site characterization, remediation, and monitoring.
http://handle.dtic.mil/100.2/ADA384783

Speciation of Gold and Copper Cyanide Complexes on Ion-Exchange Resins Containing Different Functional Groups
Lukey, Grant C. (Univ of Melbourne, Parkville); Jannie S.J. van Deventer; Ratan L. Chowdhury; David C. Shallcross; Shane T. Huntington; Craig J. Morton. Reactive and Functional Polymers, Vol 44 No 2, p 121-143, 2000

Despite the extensive work done on the use of ion exchange technology for the recovery of gold from cyanide-leached slurries, little of it has considered the effect that the chemical structure and hydrophilicity of the functional group may have on the speciation of the sorbed metal cyanide species. This study used CP/MAS 13C-NMR to determine the chemical structure of the aliphatic amino functional group on each of five synthesized resins. Raman spectroscopy was used in conjunction with FTIR spectroscopy to determine the speciation of copper(I)-cyanide and gold(I)-cyanide on each resin studied. Despite the equilibrium distribution of copper cyanide species in solution, [Cu(CN)3]2- predominantly loaded onto all resins studied; for resins of a low ionic density, the sorption of [Cu(CN)2]- was also observed. Raman spectroscopy showed that gold cyanide loads onto each resin as the linear [Au(CN)2]- complex and that no change in speciation was observed in highly saline solutions. The observed phenomena have been used to explain the selective sorption properties of each resin in non-saline and highly saline solutions.

Spectral Induced Polarization Studies of Mine Dumps near Silverton, Colorado
Campbell, D.L.; D.V. Fitterman; A.S. Hein; D.P. Jones. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 22-26 March 1998, Chicago, Illinois. p 761-769, 1998

This paper contrasts two mine dumps in Colorado, one with a low and even induced polarization (IP) response (<12 milliRadian phase shift) and a second with local highs in its IP response (>40 mR phase shifts). IP highs did not particularly correlate with conductivity highs. Analyses of composite geochemical samples showed <1 wt% sulfides in the first dump, and about 6 wt% sulfides in the second, a result that supported the geophysical interpretation.

State of the Art for Pipe & Leak Detection: A Low-Cost GPR Gas Pipe & Leak Detector
Cist, David B.; Alan E. Schutz, Geophysical Survey Systems, Inc., N. Salem, NH. U.S. DOE, National Energy Technology Laboratory website: Technology Status Assessments. 8 pp, Nov 2001

There is a limited arsenal of tools available for pipe detection. However, the diversity of techniques shows that each has advantages and shortcomings. For example, only GPR can claim to reliably detect non-metallic pipes, but may fail to detect pipes in some soils. The main categories of pipe detection tools in common use are summarized in this paper.
http://www.netl.doe.gov/scng/publications/pipe_leak.pdf

Strategies for Characterizing Subsurface Releases of Gasoline Containing MTBE
Nichols, Eric M. (LFR Levine-Fricke), Steven C. Beadle; Murray D. Einarson (Conor Pacific/EFW). American Petroleum Institute, API Publication No 4699, 116 pp, Feb 2000

This bulletin contains a detailed overview of the tools and techniques used in the field for source and pathway characterization and subsequent monitoring at oxygenate release sites, focusing on newer technologies that allow rapid collection and field analysis of soil, soil gas, and ground-water samples. The text includes a review of the expedited site assessment process, which is particularly well suited for oxygenate assessment. It also provides a comprehensive guide to modern direct-push assessment and monitoring tools, with emphasis on their proper use at MTBE-affected sites.
http://api-ep.api.org/filelibrary/4699b.pdf

Surface Acoustic Wave Mercury Vapor Sensor
Sweeney, Jim; Chris Jackson; George P. Miller, Sensor Research and Development Corp., Orono, ME. Industry Partnerships for Environmental Science & Technology, 30 October-1 November 2001, National Energy Technology Laboratory (NETL), Morgantown, West Virginia [abstract only]

This project aims to develop a fast, simple, inexpensive and reliable sensor-based instrument for detecting and monitoring low (less than 5 µg/dscm) levels of mercury emissions. The instrument is designed to be site deployable and to provide continuous data on cumulative mercury exposure and instantaneous concentration. The underlying sensing mechanism for gaseous mercury is based on surface acoustic wave (SAW) technology with a thin gold film used as an ultrasensitive microbalance. By coating the delay line with a thin gold film and configuring it as an RF oscillator, mass changes in the film can be measured by monitoring the oscillation frequency. The oscillation frequency then becomes a direct measure of the instantaneous mercury concentration. The sensor is reusable because the mercury can be driven from the film by heating it to a high temperature. A second SAW delay line without a sensing film can, if necessary, be incorporated into the device to act as a reference so that extraneous environmental effects that perturb both delay lines equally can be subtracted out. To develop the necessary knowledge base required of a commercially viable SAW-based mercury vapor sensor, important technical objectives must be accomplished: (1) development of a heater element to optimize the sorption and desorption of mercury vapor on the gold sensing film, (2) determination of the optimum gold film thickness and operating temperature for the sensing element, (3) characterization of the SAW sensor response signature, (4) determination of the sensor selectivity, (5) the effect of potential interferences, (6) fabrication of a field deployable prototype instrument, (7) extensive laboratory testing of the sensor instrument, and (8) field testing and demonstration of the sensor instrument. A field test was performed earlier this year using the gas sampling and preconditioning system at the University of North Dakota's Energy and Environmental Research Center (EERC).

Surface and Downhole EM Investigations at Potash Mine Sites in Saskatchewan, Canada: Case Histories
Phillips, G.; H. Maathuis. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, 23-26 March 1997, Reno, Nevada. p 97-106, 1997

The authors relate their practical experience using geophysics to trace plumes from potash mines. The plumes were briney, rather than acidic, but also very electrically conductive. They found electromagnetic methods cheaper than DC for their application, and compare many commercial EM instruments, with useful discussions of the strengths and weaknesses of each.

Techniques for the Determination of Cyanide in a Process Environment: a Review
Barnes, D.E. (Analytical Science Division, Mintek, Randburg, South Africa); P.J. Wright; S.M. Graham; E.A. Jones-Watson. Geostandards Newsletter: The Journal of Geostandards and Geoanalysis, Vol 24 No 2, p 183-195, 2000

The accurate determination of cyanide is difficult for various reasons. Depending on the pH of the solution, cyanide is present both in molecular form (HCN) and ionic form (CN-). Furthermore, cyanide is a good complexing reagent and reacts with almost all cations, resulting in complexes with widely varying properties, such as stabilities, solubilities and rates of reaction. Cyanide also breaks down in sunlight and air, so that sampling and sample treatment become very important aspects to consider in the methodologies. During the last fifty years, the determination of cyanide has been approached from various angles and a myriad of methods has been developed for its determination. This study represents a survey of methods commonly used in industrial laboratories for the analysis of cyanide-containing solutions. The text provides an overview of the nomenclature often used for the various forms of cyanides and an interpretation of the values resulting from a particular analysis, and identifies the most common interferences in samples originating from gold processing plants.
http://www.crpg.cnrs-nancy.fr/Geostandards/GN_pdf.v24/msvm105.pdf

A Template for Geophysical Investigations of Small Landfills
Green, Alan (ETH-Hoenggerberg, Zurich, Switzerland), Eva Lanz, Hansruedi Maurer; David Boerner (Geological Survey of Canada, Ottawa, Canada). The Leading Edge, p 248-254, Feb 1999

The authors evaluate the information content of various high-resolution geophysical data sets collected at a typical Swiss landfill. A table shows qualitatively which methods are cost and time intensive. The cost estimates are based on the number of required field personnel, the time needed to collect and process the data, and the monetary value of the recording and processing equipment. Methods that provide reliable depth information are generally more time-intensive and expensive (e.g., seismic reflection and refraction, followed by georadar). Rapid and inexpensive magnetic and band-limited electromagnetic surveys can be conducted by one or two people and involve only a small amount of processing.

Total Cyanide Determination by a Segmented Flow Injection-on-Line UV Digestion-Amperometric Method
Solujic L.; E.B. Milosavljevic (BioQuest, Reno, NV); M.R. Straka. Analyst, Vol 124 No 8, p 1255-1260, 1999

Extensive species and concentration-dependent cyanide recovery studies were carried out using a novel automated segmented flow injection-on-line UV digestion-amperometric (FI-UV) method for determinating total cyanide in water and wastewater samples, with attention to the response of the method to the presence of interferents. Data obtained in comparison tests show that the FI-UV method has significant advantages over the EPA/ASTM approved procedures. Total cyanide levels and spike recoveries were determined for nine different industrial effluents. The authors found the method to be rapid, selective, and reproducible, with a detection limit of 0.2 micrograms/L^{-1} and a throughput of 30 analyses per hour.

Towards Autonomous Environmental Monitoring Systems
Sequeira, Margaret; Michaela Bowden; Edel Minogue; Dermot Diamond, National Centre for Sensor Research, School of Chemical Sciences, Dublin City Univ., Dublin, Ireland. Talanta, Vol 56 No 2, p 355-363, 2002

New polymeric materials and strategies for integrating optical (colorimetric) detection are becoming available to support innovations such as miniaturized total analysis systems (µTAS), or Lab-on-a-Chip. Breakthroughs in apparently unrelated areas can further influence the development and/or application of monitoring technologies, such as the integration of wireless communications with micro-dimensioned analytical instruments and sensors to enhance field-based environmental measurements.

Troubleshooting HPLC Systems: A Bench Manual
Sadek, P.C. (ed.). Wiley-Interscience, New York. ISBN 0-471-17834-9, 306 pp, 1999

This text presents a complete, up-to-date guide to the use, maintenance, and troubleshooting of HPLC systems. The last twenty-five years have seen a dramatic rise in the use of High Performance Liquid Chromatography (HPLC) in laboratories worldwide. Troubleshooting HPLC Systems provides analysts as well as laboratory technicians and managers with a readily accessible and immensely useful guide to the new generation of HPLC equipment and techniques. With an emphasis on effective troubleshooting of HPLC systems, this lab companion covers system configuration and functions, problem-solving procedures, maintenance, and HPLC basics. It then walks chromatographers investigating the source of a malfunction through each system component-from solvents and reservoirs to sample preparation to columns and detectors. Special features include a detailed review of HPLC instrumentation and accessories, a discussion of the role of operating parameters as indicators of system performance, step-by-step troubleshooting protocols for each system component, how to set up a preventive maintenance program for HPLC systems, an overview of the categories of HPLC separations, a compilation of HPLC terms and definitions, and tables and charts of solvents properties.

Ultrasonic Extraction and Field-Portable Anodic Stripping Voltammetric Measurement of Lead in Dust Wipe Samples
Ashley, Kevin (National Inst. for Occupational Safety and Health, Cincinnati, OH), Tamara J. Wise, Wandaliz Mercado; Diane B. Parry (Procter and Gamble Company, Cincinnati, OH). Journal of Hazardous Materials, Vol 83 No 1-2, p 41-50, 2001

Dust wipe samples were subjected to ultrasonic extraction (UE) in diluted nitric acid, and then analyzed for lead content using field-portable anodic stripping voltammetry (ASV). Recoveries of lead were determined from wipe materials spiked with certified reference materials containing known quantities of lead: paint, soil, particulate, and dust matrices. The results of this study have provided information on the choice of wipe materials that can be used for quantitative lead measurements by UE/ASV in materials that are representative of sources of lead in surface dust.

Underground Storage Tank Location and Mapping of Former Landfills by Electromagnetic Surveys for the Delaware National Guard
Nielsen, Paul H., Engineer Research and Development Center, Champaign, IL. Construction Engineering Research Lab. Report Number: ERDC/CERL-TR-01-57; NTIS: ADA395231. 46 pp, Aug 2001

The U.S. Army Engineer Research and Development Center Construction Engineering Research Laboratory provided electromagnetic (EM) surveys to identify possible subsurface metallic features at locations in Delaware—the New Castle Rifle Range and the Bethany Beach National Guard Training Base. Surveys were conducted using multi-frequency EM profilers to induce eddy currents and measure the resultant secondary fields, giving an average conductivity value for the affected search volume. Images were generated from the data using commercial spread-sheet and mapping software. This report presents the results of the EM surveys conducted to locate subsurface metallic features at the two sites.
http://handle.dtic.mil/100.2/ADA395231

Use of a Portable Infra-Red Analyzer for Low-Level Hydrocarbon Emissions
Goldthorp, M.D. (Goldthorp Consulting, Kemptville, Ont., Canada); P. Lambert (Environment Canada, Ottawa, Ont.). Journal of Hazardous Materials, Vol 83 No 1-2, p 135-152, 2001

A portable infra-red (IR) analyzer was used successfully to monitor hydrocarbon vapors in on-site tests. The low detection limit of the IR analyzer allows it to be used in situations where ambient air levels are less than a milligram per cubic meter. The instrument also provided continuous sampling data that could indicate trends in the hydrocarbon vapor emissions. The initial tests were designed to determine if the IR analyzer was capable of monitoring low-level hydrocarbons in a field situation. The findings resulted in modification of the test procedure to include an upwind IR analyzer, shortened sampling cycles to produce more data, and additional canister samples collected outside the burn period for purposes of comparison. The IR analyzer, with a sampling cycle of approximately one minute, was able to produce a near real-time distribution of the hydrocarbon vapors in the test site emissions.

Use of Four-Dimensional Ground Penetrating Radar and Advanced Visualization Methods to Determine Subsurface Fluid Migration
Birken, Ralf; R. Versteeg, Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY. Journal of Applied Geophysics, Vol 43 No 2-4, p 215-226, 2000

Four-dimensional (4D) data sets from ground penetrating radar surveys have to be processed and visualized in a way that extracts models and allows for data visualization semi-automatically. The principles behind such an approach are applied to the Borden data set (from a site affected by DNAPLS), which is used to demonstrate how advanced visualization can assist in the interpretation of raw and processed data. Changes in reflectivity between different time-steps reveal areas of fluid migration in three dimensions. The combination of these reflectivity changes (between different combinations of the 3D subsets of the 4D data set) generates a model of hydrogeological properties. The model does not yield a quantitative description of porosity, permeability, or hydraulic conductivity, but is a qualitative proxy for a combination of these properties.

The Use of Geoelectrics and Test Wells for the Assessment of Groundwater Quality of a Coastal Industrial Site
Frohlich, Reinhard K.; Daniel W. Urish, Univ. of Rhode Island, Kingston. Journal of Applied Geophysics, Vol 50 No 3, p 261-278, 2002

Potential ground-water pollution was assessed on a former shipyard of the Newport Naval Base, RI, with geoelectrical depth soundings. Two nested test wells supported the geoelectrical interpretation, and a third well was located in a poorly accessible place. Non-invasive and cost-effective geoelectrics provide non-unique data in volume, and test wells provide laterally-confined but precise data, so a combination of both methods optimizes the results. In spite of complications due to surface constructions and the heterogeneity of the freshwater-saturated till, it was possible to identify high conductivity ground water with a conductivity on the order of 3000 µS/cm, equivalent to approximately 1950 ppm total dissolved solids (TDS). It is not possible to determine whether or how much of the TDS originates from seawater overwash and how much is attributable to shipyard activities. Test wells, however, showed objectionable amounts of dissolved metals and adsorbed toxic organic compounds.

The Use of In-Situ Testing for the Characterization of Sulphide Mine Tailings
Robertson, J.D.; W.J. Kuit; R.G. Campanella; D. Frew; H.N. McLeod; M.P. Davies. Proceedings of the 4th International Conference on Acid Rock Drainage, Vol 1, p 1761-1778, 1997

Traditional grab and/or drilling samples followed by laboratory measurements do not always provide representative analyses. In situ methods such as piezocone and discrete-depth water sampling techniques offer alternatives to traditional methods.

The Use of Transplanted Giant Clams to Identify Pollutants in Storm Water Discharges at U.S. Army Kwajalein Atoll
Brust, Colleen J.; James L. Albert. WEFTEC 2001: 74th Annual Water Environment Federation Conference and Exposition, Atlanta, Georgia, 13-17 October 2001. Water Environment Federation, Alexandria, VA. 22 pp, 2001

A study was undertaken to identify pollutants and their sources in the near-shore marine environment at U.S. Army Kwajalein Atoll. Biomonitoring was conducted in conjunction with sediment and storm water sampling. Juvenile giant clams, *Tridacna maxima*, were deployed near industrial storm water discharges in the Kwajalein Landfill and Harbor, centers of industrial activity, and at a reference site in both the dry season and wet season. Giant clams were an effective tool for identifying and monitoring pollution in a coral reef environment. Elevated levels of metals, PAHs, pesticides, and PCBs were detected in clams from both locations. Combining biomonitoring with conventional environmental sampling allowed the correlation of pollutants in organisms with sources in the environment. Trends in clam tissue, sediment, and storm water data suggested that both sediment and storm water are significant sources of the pollutants detected in clams, and may require additional control or remediation.

Using GPR and FDEM Methods to Delineate Oil Migration Pathways Through Paleochannels
Rivero, L.; N.L. Bag; N.C. Hell; M. Vilas; V. Pinto; A.L. Casas, Univ. de Barcelona, Spain. European Geophysical Society (EGS) XXV General Assembly, 25-29 April 2000, Nice, France. Geophysical Research Abstracts, CD-ROM, Volume 2, 2000

This case history concerns the use of two shallow geophysical methods to locate preferential ground-water migration pathways at an area affected by continuous industrial oil spilling near Barcelona. The contaminating source was an old oil recovery facility from whence oil waste moved along the top of water table though a coarser formation. A detailed investigation to assess the best remediation actions included boreholes and hydrogeological and geophysical studies. High-resolution EM-31 conductivity maps at 3 and 6 m depth combined with 100 MHz GPR profiles provided an almost 3-D view of the distribution and pattern of the preferential oil-migration paths though paleochannels. Geophysical interpretation was in agreement with pit excavations and soundings. Based on the characterization data, a physical barrier with two filtering gates was constructed to isolate the contaminant plume.

Using Perfluorocarbon Tracers for Verification of Cap and Cover Systems Performance
Heiser, J.; T. Sullivan, Brookhaven National Lab., Upton, NY. Report No: BNL-52647, 25 pp, Nov 2001

There has been considerable concern at DOE facilities about long-term stewardship issues in general, and verification and long-term monitoring (LTM) of caps and covers, in particular. Every buried waste site within the DOE complex will require some form of cover system. These covers are expected to last from 100 to 1000 years or more. DOE has set up a national committee of experts to develop a long-term capping (LTC) guidance document. Covers are subject to subsidence, erosion, desiccation, animal intrusion, plant root infiltration, etc., all of which will affect the overall performance of the cover. Current long-term monitoring methods can only indicate that failure of the cover system has already occurred and contaminants have been transported away from the site. Methods that indicate cover

failure prior to contaminant release or predict approaching cover failure are needed. The LTC committee has identified predictive monitoring technologies as a high priority need for DOE, for new covers as well as existing covers. A Brookhaven National Laboratory (BNL) technology may be capable of meeting the requirements for LTM. The technology employs perfluorocarbon tracers (PFTs) to determine flaws (e.g., holes or cracks) and high permeability areas in subsurface barriers. Gaseous tracers are injected on one side of the barrier and searched for on the opposite side of the barrier. The sampling grid, concentration, and time of arrival of the tracer(s) on the opposite side help to determine the size and location of flaws and relative permeability of the barrier. In addition, use of multiple tracers allows different tracers to be injected in different quadrants of the barrier to yield additional information on barrier transport phenomena.
http://www.osti.gov/gpo/servlets/purl/790183-RHyvfh/native/

X-Ray Fluorescence Spectrometry, Second Ed.
Jenkins, Ron. Wiley-Interscience, New York. ISBN: 0-471-29942-1, 232 pp, 1999

The second edition updates all previous material and adds new chapters on such topics as the history of X-ray fluorescence spectroscopy, the design of X-ray spectrometers, state-of-the-art applications, and X-ray spectra. The author first covers the basic aspects of X rays, followed by the methodology of X-ray fluorescence spectroscopy and available instrumentation. He offers a comparison between wavelength and energy dispersive spectrometers, as well as step-by-step guidelines to X-ray spectrometric techniques for qualitative and quantitative analysis -- from specimen preparation to real-world industrial application. The text includes a critical review of the most useful X-ray spectrometers.

Characterisation of Passive Leachate Treatment Systems by Quantitative PCR Analysis
Moffett, B.F., Lead Researcher, Univ. of East London, UK. Engineering and Physical Sciences Research Council (EPSRC) Reference: GR/M89553/01

Active pollution control systems at landfill sites are expensive to operate. To operate passive leachate treatment systems, the microbial communities responsible for the treatment must be characterized in terms of composition and population dynamics. Using the Pitsea site as a model, the researchers will characterize quantitatively the microbial communities responsible for the treatment within the perimeter ditch. This will be achieved by the molecular analysis of 16S rDNA extracted from the samples to identify both culturable and non-culturable bacteria. Identification of a portion of the organisms present will be by reference to available databases. Quantification of known and unknown groups will be achieved using real-time quantitative PCR analysis, which requires a high specification thermal cycler able to monitor the accumulation of amplification products as the reaction proceeds. The information gained will enable the efficiency of passive treatment systems within the perimeter ditches at Pitsea and similar landfill sites to be increased by appropriate management regimes. The probes that will be developed are likely to find numerous applications in the landfill and water treatment industries. This research project began 1 November 1999 and ends 31 October 2002, with £227,209 in funding. It is sponsored by the Engineering and Physical Sciences Research Council (EPSRC), the largest of the seven UK Research Councils.

The Environmental Fate of Chiral Compounds and Their Use as Indicators of In Situ Biodegradation
Williams, G.M., Lead Researcher (gmw@bgs.ac.uk), British Geological Survey. Engineering and Physical Sciences Research Council (EPSRC) Reference: GR/N25831/01

Many organic compounds are chiral, that is, they exist in left- or right-handed forms that have identical physical and chemical properties, but can behave completely differently in biological systems. If their environmental behavior can be understood, then this difference may be used to assess their extent of biodegradation in aquifers and so provide evidence of natural attenuation (NA). A field site where the chiral herbicide mecoprop is polluting a major aquifer will be studied in a feasibility study to develop protocols for using enantiomeric ratios for assessing NA. This work will involve a series of in situ and laboratory microcosm experiments, focusing on the degradation and microbially mediated inversion of one form to the other, which is an important stage in the degradation process. The results will help explain the dynamics of chiral inversion and biodegradation and will aid the development of a kinetic model to predict chiral ratios and concentrations in different redox zones in the aquifer. The work will also involve a review of chiral priority pollutants, and the assembly of data of relevance to their environmental fate. Potential field sites for future application of the protocols developed in this feasibility study will also be considered. This research project began 21 August 2000 and ended 20 March 2002, with £60,804 in funding. It was sponsored by the Engineering and Physical Sciences Research Council (EPSRC), the largest of the seven UK Research Councils.

In Situ Sensing of the Effect of Remediation on Available Metal Fluxes in Contaminated Land

Davison, W., Lead Researcher, Lancaster Univ., UK. Engineering and Physical Sciences Research Council (EPSRC) Reference: GR/M33594/01

Risks posed by heavy metals in contaminated land are related to their mobility, bio-availability, and toxicity. These factors are affected by chemical speciation and the kinetics of exchange between solid phase and solution. The new technique of diffusive gradients in thin films (DGT) uses simple, inexpensive, plastic devices based on gel technology to measure the rate of resupply of metals from solid phase to solution. By combining with measurements of soil solution concentrations, DGT can be used to provide hazard factors solely from soil solution that are quantitative assessments of the enhancement of available metal in a soil over the supply. Systematic measurements of hazard factors in soil samples from contaminated land were related to physiochemical soil properties and to microbial populations. In situ DGT probes were developed and tested by comparing in situ DGT fluxes and hazard factors with those determined in samples returned to the laboratory. They will be used to assess the small-scale spatial variability in metal resupply. The work will be fully integrated with an existing program on the effects of remediation and will provide complimentary information on changes in metal dynamics. This research project began 15 March 1999 and ended 14 March 2002, with £165,057 in funding. It was sponsored by the Engineering and Physical Sciences Research Council (EPSRC), the largest of the seven UK Research Councils.

Non-Invasive Characterisation of NAPL-Contaminated Land by Spectral Induced Polarisation (SIP) Tomography

Ogilvy, R.D. (r.ogilvy@bgs.ac.uk) Lead Researcher, British Geological Survey. Engineering and Physical Sciences Research Council (EPSRC) Reference: GR/M34010/01

Non-aqueous phase liquids (NAPLs) such as chlorinated solvents, coal-tars, and hydrocarbons are a group of common soil and ground-water contaminants that pose unique problems for detection by non-invasive geophysical techniques. NAPLs are sparingly soluble and invariably occur as capillary trapped residuals in the pore-space. Recent research shows that spectral induced polarization (SIP) tomography has the potential to detect and image NAPL distributions in the shallow subsurface. SIP measurements the frequency dependence of rock electrical properties in the bandwidth mHz - kHz, and different phase spectra can be expected when NAPLs interact with pore-mineral surfaces. The project aims to investigate the complex geoelectric properties of NAPL-contaminated Triassic sandstone rocks, simulate NAPL migration in porous and fractured media using tank experiments, develop new 2.5D mathematical algorithms for the inversion and reconstruction of SIP images over the full frequency range, and undertake field tests in controlled environments to validate the laboratory, tank, and theoretical predictions. Industrial partners (BG, ICI, and Shell) will provide test sites, geochemical control, and ground-truth. This research project began 30 March 1999 and ends 30 September 2002, with £221,610 in funding. It is sponsored by the Engineering and Physical Sciences Research Council (EPSRC), the largest of the seven UK Research Councils.

Non-Invasive Detection of Oil and Solvent Contamination by Spectral Induced Polarisation (SIP) Tomography

Barker, R.D. (r.d.barker@bham.ac.uk) Lead Researcher, Univ. of Birmingham, UK. Engineering and Physical Sciences Research Council (EPSRC) Reference: GR/M40011/01

This research project began 1 October 1999 and ends 30 June 2003, with £92,491 in funding. It is sponsored by the Engineering and Physical Sciences Research Council (EPSRC), the largest of the seven UK Research Councils.