

Measurement & Monitoring: 25th Quarterly Literature Update

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Acid Rock Drainage and Metal Leaching from Mine Waste Material (Tailings) of a Pb-Zn-Ag Skarn Deposit: Environmental Assessment through Static and Kinetic Laboratory Tests
Mendez-Ortiz, B.A., A. Carrillo-Chavez, and M.G. Monroy-Fernandez.
Revista Mexicana de Ciencias Geologicas, Vol 24, No 2, p 161-169, 2007

Characterization of the processes and products involved in the generation of acid rock drainage/metal leaching (ARD/ML) from mine tailings was examined in static and kinetic laboratory tests of historic and recent tailings, as well as by mineralogical characterization of solids and chemical analyses of solids and leachates. Pyrite was the most abundant sulfide phase, and one of the main minerals promoting ARD/ML generation, followed by pyrrhotite and arsenopyrite. Carbonates were present as calcite and lesser amounts of ankerite. Smaller concentrations of quartz and feldspar also were identified. Results of the static tests (acid base accounting) indicate that both recent and historic tailings have a likely ARD/ML potential (neutralization potential, or NP of less than 1). Kinetic tests were performed in humidity cells to simulate the natural oxidation of primary mineral samples; the obtained leachates had circum-neutral pH values (4.5 to 7.9) and relatively low heavy metals contents. The oxidation-neutralization curves nonetheless suggest that oxidation capacity in both sample types is higher than their neutralizing capacity and that sulfide oxidation is more important in historic than in recent tailings. The information obtained, along with statistical tests (F ratio and t-student), demonstrated that the tailings have a strong capacity to generate ARD/ML and that the particular characteristics of the historic and recent mine waste materials created different conditions for its generation. [http://satori.geociencias.unam.mx/24-2/\(3\)Mendez.pdf](http://satori.geociencias.unam.mx/24-2/(3)Mendez.pdf)

Advances in Perimeter Air Monitoring During the Cleanup of Former MGP Sites
Schulz, Stuart P., Stephen F. Takach, and Timothy R. Minnich.
Submitted for publication (Requested) in The Professional Geologist, 8 pp, 2007

This paper describes advances in the use of optical remote sensing (ORS) as applied to perimeter air monitoring during the cleanup of former manufactured gas plant (MGP) sites. An ORS-based perimeter air monitoring program was carried out by Atmos Energy Corporation during the November 2004 cleanup of an MGP site in Bristol, Tennessee. Atmos Energy selected open-path Fourier-transform infrared (FTIR) spectroscopy as the air monitoring method for use at the Bristol site. An EDO Corporation RAM2000 open-path FTIR spectrometer was used to measure 14 gaseous target compounds, including benzene and naphthalene, along the downwind site perimeter about 1.5 meters above the ground. A Climatronics TACMET Weather Sensor equipped to monitor wind speed, wind direction, and the standard deviation of the horizontal wind direction was also employed. Besides its ability to meet the above objectives, the ORS technology was chosen because of its proven track record in numerous Superfund site cleanups and its status as an EPA-approved ORS method (Toxic Organic Compendium Method 16, U.S. EPA, 1999). The Gas Technology Institute (GTI) is conducting a 26-month R&D initiative to build upon the demonstrated success of this technology. GTI hopes to gain support from EPA for

the standardization and regulatory acceptance of this air monitoring approach for MGP site cleanups around the nation. <http://msiair.net/web%20-%20Paper%201.pdf>

Air Concentrations of PCDD/Fs, PCBs and PCNs Using Active and Passive Air Samplers
Mari, M., M. Schuhmacher, J. Feliubadalo, and J.L. Domingo, Rovira i Virgili Univ., Spain.
Chemosphere, [prepublication] 2007

Concentrations of polychlorinated dibenzo-p-dioxins and furans (PCDD/Fs), polychlorinated biphenyls (PCBs), and polychlorinated naphthalenes (PCNs) were determined in air samples collected using high-volume active samplers at four sampling sites located in two zones near a municipal solid waste incinerator and a combined-cycle power plant (3 sites), and at a background/control site. Four PUF passive samplers were deployed at the same sampling points during a 3-month period. For PCDD/Fs in the active samplers, total WHO-TEQ values were 27.3 and 10.9fg WHO-TEQm(-3) at the urban/industrial and the background sites, respectively. The sums of 7 PCB congeners and the PCN levels were also higher at the industrial site than at the background site. The accumulated amounts of PCDD/Fs, PCBs, and PCNs were also determined in the four passive air samplers. Comparison of all the sampling results showed that PUF disks allowed differences to be established among zones for the POP levels and provided a suitable method to determine POP concentrations in air in areas with various potential emission sources. Although both particle and gas phase were sorbed by the PUFs, the data for gas-phase congeners are more reproducible.

Air Pollution Monitoring Using the Open Path Technique
Belegante, L., D. Zisu, I. Ionel, and A. Nemuc.

Remote Sensing of Clouds and the Atmosphere XII.

Proceedings of SPIE -- The International Society for Optical Engineering, Volume 6745, 2007

The open-path technique can detect trace gases down to ppb concentrations and is widely used for air pollution monitoring. A DOAS system can measure several types of atmospheric molecular compounds having UV absorption spectra simultaneously by averaging over an optical path up to hundreds of meters in length. The authors analyze and compare measurements by DOAS (open path) and in situ detectors (a standardized point-monitoring technique) in highly polluted areas of Bucharest. This comparison reveals strengths and weaknesses of the open path technique. This paper identifies the main environmental conditions (e.g., atmospheric fluctuations, topography) responsible for important differences in the experimental data acquired with the two techniques.

Amperometric Detection of Triazophos Pesticide Using Acetylcholinesterase Biosensor Based on Multiwall Carbon Nanotube/Chitosan Matrix

Du, Dan, Xi Huang, Jie Cai, and Aidong Zhang.

Sensors and Actuators B: Chemical, Vol 127 No 2, p 531-535, 15 Nov 2007

A sensitive, fast, and stable amperometric sensor for quantitative determination of organophosphorous pesticide was developed based on a simple method for immobilization of acetylcholinesterase (AChE) on multiwall carbon nanotubes (MWNTs)/chitosan (MC) composite. This matrix possesses a homogeneously netlike structure that prevents the enzyme from leaving the electrode. MWNTs promoted electron transfer reactions at a lower potential and

catalyzed the electro-oxidation of thiocholine, thus increasing detection sensitivity. Based on the inhibition of organophosphorous pesticide to the enzymatic activity of AChE, the conditions for detection of a pesticide were explored using triazophos as the model compound. Under optimal conditions, the inhibition of triazophos was proportional to its concentration in two ranges, from 0.03 to 7.8 uM and 7.8 to 32 uM with a detection limit of 0.01 uM. The inhibited AChE could be 95% regenerated within 8 min using pralidoxime iodide.

Analysis of Explosives in Soil Using Solid Phase Microextraction and Gas Chromatography
Mayfield, H.T. (Air Force Research Laboratory, Tyndall AFB, FL); E. Burr, and M. Cantrell (Applied Research Associates, Tyndall AFB).
Analytical Letters, Vol 39, p 1463-1474, 2006

It is desirable to be able to detect very low levels of explosives that are encountered in soils near unexploded explosive devices. The authors describe their efforts at adapting headspace solid phase extraction and gas chromatography/mass spectrometry to provide a sensitive analytical method for detecting explosives in soil.

<http://handle.dtic.mil/100.2/ADA449403>

Application of Tracer Test and Image Analysis on the Mass Removal and Contaminant Flux Reduction of DNAPL

Chen, X., Y. Wang, and J.W. Jawitz.

7th Annual Soil & Water Science Research Forum: Program & Abstracts, University of Florida, September 15, 2006

This research focuses on the application of reactive tracer test and image analysis on the evaluation of the relationship between contaminant mass reduction (R_m) and flux reduction (R_f) in a DNAPL. Using the concept of streamtubes, a Lagrangian analytical solution was applied in a study of contaminant dissolution that combined the aquifer hydrodynamic heterogeneities from a nonreactive tracer test and DNAPL spatial distribution heterogeneity from a reactive tracer test. The parameter of reactive travel time variability was derived from this combination of tracer tests and was used to predict the relationship between R_m and R_f . The reduction in groundwater contaminant flux resulting from partial mass removal was obtained from surfactant flushing dissolution tests through a heterogeneous chamber. Comparison of this flushing test data with the tracer test suggested that the tracer test can be used to characterize DNAPL spatial distribution heterogeneity. A simple image test technique was applied to provide the assessment of DNAPL architecture. The result of reactive travel time variability of DNAPL in this 2-D chamber as indicated by the tracer test matched the value derived from image analysis.

Applying Molecular Techniques to Bioremediation

Western Region Hazardous Substance Research Center, Brief #10, June 2006

Molecular biology tools that allow organisms to be identified and quantified on the basis of their genetic composition present an exciting opportunity for bioremediation. Researchers at the Western Region Hazardous Substance Research Center are developing applications for two of these techniques: polymerase chain reaction (PCR) and fluorescence in situ hybridization (FISH). The team's focus is on bioremediation of tetrachloroethene (PCE) and trichloroethene (TCE) and the use of molecular techniques to monitor the abundance and activity of

Dehalococcoides, a group of bacteria that can couple the detoxification of these compounds to growth through a process called metabolic halorespiration. Cleanup practitioners have promoted degradation of PCE and TCE at field sites successfully by introducing microbial enrichment cultures containing Dehalococcoides organisms. PCR and FISH techniques provide a way to identify and enumerate the microbial populations and monitor their activity in the environment with a high degree of spatial and temporal resolution. This information can then be used to create conditions that promote the microbes' performance in bioremediation.

http://wrhsrc.oregonstate.edu/briefs/brief_10.htm

Aquifer and Vadose Zone Pollution Determined from Geoelectrical Measurements with Multi-Electrode Wells and Surface Multi-Profiling

de Lima, O.A. and P. de Pereira, Federal Univ. of Bahia, Salvador, BA, Brazil.

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract H41B-07, 2007

Three years of hydrobiogeological research were conducted to describe quantitatively the underground contamination of a 4.0 km² area that includes two landfills and a tannery. Electrical geophysics, geological, geochemical, and biological analysis were used to gain a general understanding of the complex interactions between organic and inorganic pollutants and their environmental impacts. Geological reconnaissance and a geoelectrical survey using vertical electrical soundings were made around the area to detect and delineate the extent of the underground contaminant plume. The presence of a strong conductive anomaly within the aquifer was revealed, resulting from invasive fluids from the landfills and the tannery's surface disposal lagoons. The analysis of samples from available wells has shown dramatic changes in total dissolved solids, total chromium, inorganic macro-components, biochemical oxygen demand, chemical oxygen demand, nutrients, and bacterial content. Apparent resistivity and chargeability data were measured as a function of depth along three new multi-electrode wells and as a function of electrode spacing along five double semi-Schlumberger subsurface profiles. A special multi-electrode well was fitted with externally installed copper electrodes as thin metallic rings spaced by 0.50 m along its entire filter and casing length. The electrodes are connected through insulated cables to the ground surface and can be combined into different arrays. Two-side semi-Schlumberger soundings expanded up to 200 m AB/2 spacing and with centers spaced by 50 m along a special transverse centered at the plume were inverted using 1D and 2D models. Both techniques were used to detail the groundwater contamination around the landfills. The electrical measurements performed at the earth surface and within the wells were used both to characterize the plume and to estimate changes in water saturation and water chemistry below the water table and throughout the upper vadose section of the aquifer system.

Assessment of Intrinsic Bioremediation of a Coal-Tar-Affected Aquifer Using Two-Dimensional Reactive Transport and Biogeochemical Mass Balance Approaches

Rogers, S.W., S.K Ong, G.A. Stenback, J. Golchin, and B.H. Kjartanson, U.S. EPA, Cincinnati, OH.

Water Environ Res. 2007 Jan;79(1):13-28

Biogeochemical data and heterotrophic plate counts were developed from a former manufactured gas plant site characterization. These data support the presence of microbial remediation. First-order degradation rate coefficients (day⁻¹) of various compounds for the dissolved-phase plume were estimated (i.e., benzene [0.0084], naphthalene [0.0058], and

acenaphthene [0.0011]) using a two-dimensional reactive transport analytical model. The total mass transformed by microbial degradation around the free-phase coal-tar dense-nonaqueous-phase-liquid region and in the plume was estimated to be approximately 4.5 kg/y using a biogeochemical mass-balance approach. These results showed that a simple two-dimensional analytical model combined with a biochemical mass balance can be useful for rapidly estimating mass-transformation rates.

ASTM D2036-06: Standard Test Methods for Cyanides in Water
American Society for Testing and Materials, Vol 11.02, 2006

These test methods cover the determination of cyanides in water. Cyanogen halides can be determined separately. Cyanogen chloride is the most common of the cyanogen halide complexes as it is a reaction product and is usually present when chlorinating cyanide-containing industrial waste water. For the presence or absence of $CNCl$, the spot test method can be used. These test methods do not distinguish between cyanide ions and metalocyanide compounds and complexes, nor do they detect the cyanates. The cyanide in cyanocomplexes of gold, platinum, cobalt, and some other transition metals is not completely recovered by these test methods. Cyanide from only a few organic cyanides is recovered, and those only to a minor extent. Part or all of these test methods have been used successfully with reagent water and various waste waters. It is the user's responsibility to ensure the validity of the test method for the water matrix being tested.

ASTM D4374-06: Standard Test Methods for Cyanides in Water--Automated Methods for Total Cyanide, Weak Acid Dissociable Cyanide, and Thiocyanate
American Society for Testing and Materials, Vol 11.02, 2005

These test methods cover the determination of different species of cyanides and thiocyanate in water and waste water, i.e., weak acid dissociable cyanide, total cyanide, and thiocyanate. The test method for total cyanide determines all the weak acid dissociable cyanides and the strong metal-cyano-complexes, such as ferrocyanide, ferricyanide, hexacyanocobaltate, and those of gold and platinum. The test method for weak acid dissociable cyanide basically determines free cyanides, as CN and HCN , and weak metal-cyano-complexes such as $[Cd(CN)_4]^{2-}$ and $[Mn(CN)_6]^{3-}$. Iron complexes are not included. Strong cyanide complexes, like those of iron, cobalt, etc., can be determined by difference. The test method for thiocyanate determines the thiocyanate as the difference between another measurement that includes total cyanide plus thiocyanate and the value of total cyanide, that is, $thiocyanate = total\ cyanide\ plus\ thiocyanate - total\ cyanide$. Cyanates and cyanogen halides are not detected. Cyanogen chloride hydrolyzes to cyanate at the pH of sample preservation. Most of the organo-cyano-complexes are not measured, with the exception of the weak cyanohydrins. These test methods apply to different types of water, waste water (raw sewage, sludge, and effluent), sludge, some industrial waste, and sediments. Sample matrixes should be evaluated by the user. The reported precision and bias may not apply to all samples.

ASTM D6696-05e1: Standard Guide for Understanding Cyanide Species
American Society for Testing and Materials, Vol 11.02, 2005

This guide defines standard terminology used for the classification of the various chemical forms of cyanide. It provides a general understanding of the chemical nature of distinct cyanide species as related to chemical analysis and environmental fate and transport.

ASTM D6888-04: Standard Test Method for Available Cyanide with Ligand Displacement and Flow Injection Analysis (FIA) Utilizing Gas Diffusion Separation and Amperometric Detection
American Society for Testing and Materials, Vol 11.02, 2004

This method is used to determine the concentration of available inorganic cyanide in an aqueous wastewater or effluent. The method detects the cyanides that are free (HCN and CN-) and metal-cyanide complexes that are easily dissociated into free cyanide ions. The method does not detect the less toxic strong metal-cyanide complexes, cyanides that are not "amenable to chlorination." Total cyanide can be determined for samples that have been distilled as described in Test Methods D2036, Test Method A, Total Cyanides after Distillation. The cyanide complexes are dissociated and absorbed into the sodium hydroxide capture solution, which can be analyzed with this test method; therefore, ligand exchange reagents from sections 8.12 and 8.13 would not be required when determining total cyanide after distillation. This procedure is applicable over a range of approximately 2 to 400 ug/L available cyanide. Higher concentrations can be analyzed by dilution or lower injection volume.

ASTM D6994-04: Standard Test Method for Determination of Metal Cyanide Complexes in Wastewater, Surface Water, Groundwater and Drinking Water Using Anion Exchange Chromatography with UV Detection
American Society for Testing and Materials, Vol 11.02, 2004

This test method covers the determination of the metal cyanide complexes of iron, cobalt, silver, gold, copper, and nickel in groundwater, surface water, drinking water and wastewater by anion exchange chromatography and UV detection. The use of alkaline sample preservation conditions ensures that all metal cyanide complexes are solubilized and recovered in the analysis. Metal cyanide complex concentrations between 0.20 to 200 mg/L can be determined by direct injection of the sample. This range will differ depending on the specific metal cyanide complex analyte, with some exhibiting greater or lesser detection sensitivity than others. Concentrations greater than the specific analyte range may be determined after appropriate dilution. This test method is not applicable for matrices with high ionic strength (conductivity greater than 500 meq/L as Cl) and TDS (greater than 30,000 mg/L), such as ocean water. Metal cyanide complex concentrations less than 0.200 mg/L can be determined by on-line sample preconcentration coupled with anion exchange chromatography. This range will differ depending on the specific metal cyanide complex analyte, with some exhibiting greater or lesser detection sensitivity than others. The preconcentration method is not applicable for silver and copper cyanide complexes in matrices with high TDS (greater than 1,000 mg/L). The test method may also be applied to the determination of additional metal cyanide complexes, such as those of platinum and palladium.

ASTM D7237-06: Standard Test Method for Aquatic Free Cyanide with Flow Injection Analysis (FIA) Utilizing Gas Diffusion Separation and Amperometric Detection
American Society for Testing and Materials, Vol 11.02, 2006

This test method is used to establish the concentration of aquatic "free" cyanide in an aqueous wastewater or effluent. The test conditions of this method are used to measure free cyanide (HCN and CN⁻) and cyanide bound in the metal-cyanide complexes that are easily dissociated into free cyanide ions at the pH of the aquatic environment ranging from a pH of 6 to 8. The extent of HCN formation is less dependent on temperature than the pH; however, the temperature can be regulated if deemed necessary to further simulate the actual aquatic environment. The aquatic free cyanide method is based on the same instrumentation and technology that is described in standard test method D6888, but employs milder conditions (pH 6-8 buffer versus HCl in the reagent stream), and does not utilize ligand displacement reagents. The aquatic free cyanide measured by this procedure should be similar to actual levels of HCN in the original aquatic environment. This in turn may give a reliable index of toxicity to aquatic organisms. This procedure is applicable over a range of approximately 2 to 500 ug/L aquatic free cyanide. Sample dilution may increase cyanide recoveries depending on the cyanide speciation; therefore, it is not recommended to dilute samples. Higher concentrations can be analyzed by increasing the range of calibration standards or with a lower injection volume.

ASTM D7365-07: Standard Practice for Sampling, Preservation and Mitigating Interferences in Water Samples for Analysis of Cyanide
American Society for Testing and Materials, Vol 11.02, 2007

This practice is applicable for the collection and preservation of water samples for the analysis of cyanide. This practice also addresses the mitigation of known interferences prior to the analysis of cyanide. The sampling, preservation, and mitigation of interference procedures described in this practice are recommended for the analysis of total cyanide, available cyanide, weak acid dissociable cyanide, and free cyanide by Test Methods D2036, D4282, D4374, D6888, D6994, and D7237. This practice can also be applied to other cyanide methods, for example, U.S. EPA Method 335.4 and Standard Methods 4500-CN-C.

Atmospheric Monitoring at Abandoned Mercury Mine Sites in Asturias (NW Spain)
Loredo, J., J. Soto, R. Alvarez, and A. Ordonez, Univ. of Oviedo, Oviedo, Asturias, Spain.
Environmental Monitoring and Assessment, Vol 130 Nos 1-3, p 201-214, 2007

The authors have synthesized current knowledge about atmospheric mercury (Hg) content in the area of the abandoned Hg mining and smelting works located in the Mieres and Pola de Lena districts, respectively, in Asturias, Spain. The average atmospheric Hg concentrations are higher than background for the area (i.e., 0.1 µg/Nm³), as high as 203.7 µg/Nm³ at 0.2 m above the ground level. Past Hg mining activities appear to have influenced the increased Hg concentrations around these abandoned sites, suggesting that atmospheric transfer is a major pathway for Hg cycling in this area.

Bacterial Nanowires: Is the Subsurface Hardwired?

Gorby, Y.A. (Pacific Northwest National Lab, Richland, WA); C. A. Davis, E. Atekwana, and E. Atekwana (University of Missouri-Rolla).

Eos: Transactions of the AGU, Vol 87 No 36, Jt. Assem. Supplement, Abstract NS34A-03, 2006

Bacteria can produce appendages referred to as bacterial nanowires. These nanowires are electrically conductive. Dissimilatory metal-reducing bacteria, including *Shewanella oneidensis* and *Geobacter sulfurreducens*, produce nanowires in direct response to electron acceptor limitation and facilitate electron transfer to solid-phase iron oxides. Nanowires produced by *S. oneidensis* strain MR-1, the primary model organism, were functionalized by decaheme cytochromes MtrC and OmcA distributed along the length of the nanowires. Mutants deficient in MtrC and OmcA produced nanowires that were poorly conductive. The mutants also differed from wild-type cells in their ability to reduce solid-phase iron oxides, to produce electrical current in an unmediated microbial fuel cell, and to form complex biofilms at air/liquid interfaces. Results obtained using direct cell counts and low-frequency electrical measurements show that microbial growth correlated with real and imaginary electrical conductivity response in uncoated silica sand columns. Direct observation of packing material with environmental scanning electron microscopy revealed a fine network of extracellular structures that were morphologically similar to nanowires observed in metal-reducing bacteria. No such structures were observed in control columns. The authors hypothesize that microbial nanowires may be partly responsible for the electrical response observed in the biostimulated columns.

Biogeophysical Monitoring: Isolating the "Bio" From the "Geo"

Williams, K.H. and K. MacFarlane (Univ. of California, Berkeley); S.S. Hubbard (Lawrence Berkeley National Lab, Berkeley, CA).

Eos: Transactions of the AGU, Vol 87 No 36, Jt. Assem. Supplement, Abstract NS41A-06, 2006

Time-lapse geophysical methods are being evaluated for the feasibility of using them to monitor changes in the physical properties of the subsurface during stimulated bioremediation. The methods could be used to discriminate between a host of coupled biogeochemical processes, such as gas generation and mineral alteration. Although utilizing geophysical techniques to monitor these complex phenomena has shown great promise, dealing with non-uniqueness issues and the ability to discriminate between biotic and abiotic processes presents a significant challenge. Given the great diversity in potential mineralogical and microbiological pathways following carbon amendment, great care must be taken in interpreting biogeophysical datasets and the observed responses. Examples from lab and field are provided to illustrate the difficulty in ascribing variations in the geophysical response to a single process. Specifically, changes in pore fluid composition and mineralogical makeup have been observed to yield time-varying geophysical responses that are not solely the result of microbial activity. The rush to ascribe any and all regions of anomalous geophysical response to biology must be tempered with consideration of multiple lines of evidence, including the complete suite of observed changes in geochemistry, mineralogy, and microbiology, and the integration of all available data and models via estimation frameworks that can handle non-uniqueness.

Bioluminescent Bioreporter Integrated Circuit Detection Methods

Simpson, M.L., M.J. Paulus, G.S. Sayler, B.M. Applegate, and S.A. Ripp for UT-Battelle, LLC, Oak Ridge, TN.

European Patent Office, European Patent Specification EP 1 317 666 B1, 137 pp, 2007

A bioluminescent bioreporter is genetically engineered to produce light when a particular substance such as naphthalene, benzene, toluene, xylenes and isopropylbenzene is metabolized. Bioluminescent reporters have been widely used for the real time non-destructive monitoring of gene expression to whether or not conditions are favorable for the biodegradation of these chemicals. Electronic circuitry such as an optical application specific integrated circuit (OASIC) can be used to detect a luminescent response. To achieve maximum sensitivity to the luminescent response, the OASIC should be sensitive to light in the 400 nm to 700 nm (visible) range, have low current leakage and noise, and should have low sensitivity to changes in temperature and humidity.

<http://www.epo.org/patents/patent-information/european-patent-documents/publication-server.html?iAction=3&cc=EP&pn=1317666&ki=B1>

Biosensing Environmental Pollution

Ron, Eliora Z., Tel Aviv Univ., Israel.

Current Opinion in Biotechnology, Vol 18 No 3, p 252-256, June 2007

Whole-cell biosensors are constructed through the fusion of promoters (that respond to the relevant environmental conditions) to easily monitored reporter genes. Depending on the choice of reporter gene, expression can be monitored by the production of fluorescence, electrochemical reactions, color, or light. Recent advances in this area have included the development of biosensors of compact size that enable on-line and in situ monitoring of a variety of environmental parameters.

Biosensor for Heavy Metals Using Hydrothermally Grown ZnO Nanorod/Nanotube and Metal-Binding Peptides

Jia, W., E.T. Reitz, and Y. Lei, Univ. of Connecticut.

Nanotech 2007: Technical Proceedings of the 2007 NSTI Nanotechnology Conference and Trade Show. NSTI: Nano Science & Technology Institute, ISBN: 1-4200-6183-6, Vol 2, p 508-510, 2007

The authors report the development of a biosensor for determination of heavy metals based on hydrothermally grown ZnO nanorod/nanotube and metal-binding peptides. Heavy metal binding with peptide causes an electrical signal change that is measured and correlated to the concentration of heavy metals. The sensor performance was optimized with respect to the operating conditions. The new biosensor offers great promise for rapid environmental monitoring of heavy metals.

Cadmium Arachidate Single-Walled Carbon Nanotubes Composites as Sensitive Coatings for High Sensitivity Fiber Optic Chemo-Sensors

Consales, M., A. Crescitelli, A. Cutolo, M. Penza, P. Aversa, M. Giordano, and A. Cusano. Third European Workshop on Optical Fibre Sensors.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6619, 2007

Researchers investigated the feasibility of exploiting optoelectronic chemo-sensors based on cadmium arachidate/single-walled carbon nanotube composites for detection of chemical pollutants in air and water. The nanocomposite sensing layers have been transferred upon the distal end of standard optical fibers by the Langmuir-Blodgett technique. Single wavelength reflectance measurements were carried out to monitor chemical concentrations through changes in the optical length of the Fabry-Perot cavity induced by the interaction of the sensitive layer with the analyte molecules. The preliminary results indicate good potential by the fiber optic nanosensors to detect toluene and xylene at ppm levels in both air and water at room temperature.

Characterization and Optimization of a High Surface Area-Solid Phase Microextraction Sampler for the Collection of Trace Level Volatile Organic Compounds in the Field

McDonald, Shannon S., Master's thesis, Uniformed Services Univ. of the Health Sciences, Bethesda, MD. 68 pp, 2006

A prototype rapid, high-volume air sampling device based on solid phase microextraction (SPME) has been developed for the collection of trace level volatile organic compounds (VOCs). The high surface area-SPME (HSASPME) device contains 10 times more polymer than traditional SPME fibers and is uniquely designed to optimize compound uptake at higher flow rates. This study evaluated the extraction efficiency at six air sampling flow rates ranging from 0.1 L/min to 10 L/min and compared total compound extraction at the two extreme flow rates. A 10 ppb(v) concentration of 39 volatile organic compounds was used. Carboxen/poly(dimethylsiloxane) and poly(dimethylsiloxane) polymer coatings were evaluated using an Agilent 6890N/5973, a resistively heated low thermal mass gas chromatograph column, and an Entech 7100 preconcentrator. Larger extraction efficiencies were observed at lower flow rates, but the higher flow rates proved superior in total compound extraction per unit time. Across the range of compounds, the HSASPME device achieved an average 8-fold increase in compound uptake at a flow rate of 10 L/min as compared to 0.1 L/min.

<http://handle.dtic.mil/100.2/ADA459030>

Characterization of Contaminated Soils Associated with Metal-Mine and Mineral-Processing Waste in the Northeast Stockton Study Area, Jacobs Smelter, OU2 Superfund Site, Tooele County, Utah

White, W.W., III, K. Ford, and T. Ingwell, Bureau of Land Management.

The 29th Annual Conference: National Association of Abandoned Mine Land Programs (NAAML), 7-10 October 2007, Bloomington, Indiana: Program and Abstracts.

Work was conducted from 2005 to 2006 at the Northeast Stockton Study Area of the Jacobs Smelter Superfund Site to determine the source and extent of contaminated soil requiring removal. Two waste-rock dumps and a series of ribbon-shaped mineral-processing waste deposits are the source of contaminated soil. The waste deposits were covered with large- and small-spacing sampling grids, which collectively covered 65 acres. A total of 421 soil samples

was collected from these grids and from intermittent stream sediments. Soil samples were chemically analyzed for lead and arsenic using a Niton 702 portable X-ray fluorescence (XRF) spectrometer. Mineralogical characterization by optical and electron microprobe microscopy was performed on selected samples. Areal extent of the contaminated soils was measured with survey and reconnaissance-grade global positioning system (GPS) instruments, and confirmed by geologic mapping and portable XRF chemical analyses. Contaminated soil volumes were calculated by importing the GPS-determined areas into ArcGIS and employing its Geostatistical Analyst extension to create lead and arsenic-concentration isopach maps. The statistical method used to create the isopach maps was inverse distance-weighted (IDW) interpolation. The resulting IDW surfaces combined with lead and arsenic contamination depths were converted to grids and their area and volume determined by ArcGIS 3D Analyst. Based on the calculated area and volume of contaminated soil, and using 2,140 and 7,140 mg/kg XRF-lead concentrations as respective equivalents to EPA capping and removal action levels, the investigators concluded that (1) about 5 acres with nearly 11,400 cubic yards of contaminated soil equal or exceed 7,140 mg/kg lead and require removal, and (2) nearly 20 acres of contaminated soil ranging from 2,140 to 7,140 mg/kg lead require a 1-foot depth capping with nearly 32,000 cubic yards of clean soil.

Characterization of Ligand-Functionalized Microcantilevers for Metal Ion Sensing

Dutta, P., P. Chapman, P.G. Datskos, and M.J. Sepaniak.

Analytical Chemistry, Vol 77 No 20, p 6601-6608, 2005

A sensor for metal cations is based on single and binary mixtures of different thiolated ligands as self-assembled monolayers (SAMs) functionalized on silicon microcantilevers (MCs) with gold nanostructured surfaces. Binding of charged metal ions to the active surface of a cantilever induces an apparent surface stress, causing static bending of the MC, which can be detected by a beam-bending technique. An MC response mechanism based on changes in surface charge is discussed. The monodentated ligands arranged as SAMs on the MC surface are not expected to satisfy fully the coordination sphere of the detected metals, which leads to lower binding constants than would be expected for chelating ligands. The modest binding constants are compensated in terms of the magnitudes of responses by the inherent higher sensitivity of the nanostructured approach as opposed to more traditional smooth surface MCs. Limits of detection for the tested mono-, di-, and trivalent metal ions are in the low to submicromolar range. The response factors for a given SAM with the tested metal ions, or for a given metal with the tested SAMs, varied by roughly one order of magnitude. While the observed selectivity is not large, it is anticipated that sufficient ionic recognition contrast is available for selective metal ion identification when differentially functionalized arrays of MCs (different ligands on different cantilevers in the array) are used in conjunction with pattern recognition techniques.

<http://www.mnl.ornl.gov/Publications/Dutta-2005.pdf>

Characterization of SU-8 Optical Multimode Waveguides for Integrated Optics and Sensing on Microchip Devices

Piruska, A.; A.A.S. Bhagat; K. Zhou; E.T.K. Peterson; I. Papautsky; C.J. Seliskar.

Microfluidics, BioMEMS, and Medical Microsystems IV.

Proceedings of SPIE -- The International Society for Optical Engineering, Volume 6112, 2006

The authors are developing chemical sensors within integrated microfluidic systems for sensitive and selective detection of heavy metal pollution in aqueous environments. The approach is to combine established chemical sensing strategies with microfluidic structures to achieve a total heavy metal analysis system. The combination of three complementary

techniques—optical waveguide spectroscopy, electrochemistry, and chemical partitioning—offers the selectivity and sensitivity essential for many environmental samples. On-chip optical waveguide spectroscopy promises to yield the necessary high sensitivity but relies on fabrication of optical structures with a material of appropriate refractive index, optical quality, and chemical stability by methods consistent with established fabrication methods. SU-8, the epoxy-based negative photoresist, appears to satisfy these requirements and has thus become a candidate material for waveguide fabrication on plastic microchips. Although the SU-8 has been used previously for waveguide fabrication, its optical properties and more specifically the influence of processing conditions on resultant optical properties have not been thoroughly characterized. This work presents an evaluation of SU-8-based multimode waveguides on glass and plastic substrates. Optical constants of waveguides have been characterized by spectroscopic ellipsometric and prism coupling techniques. Using the latter method, evaluation of propagation losses of various structures with different thicknesses has been made. Ellipsometric and prism coupling measurements gave comparable refractive indices for variously cured SU-8 waveguide materials. Prism coupling analyses proved to be more useful for analysis of the many SU-8 waveguide structures fabricated in the thickness range of 5 to 75 μm .

Classification Methods for Oil Spill Detection in ENVISAT ASAR Images

Brekke, C. (Forsvarets Forsknings Inst. and Univ. Oslo, Norway) and A. Solberg (Univ. Oslo, Norway).

Image and Signal Processing for Remote Sensing XII.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6365, 2006

Oil spills appear as dark areas in SAR images because the oil dampens the capillary waves of the sea surface. A combined use of satellite-based SAR and aircraft surveillance flights is a cost-effective way to monitor large areas. A major part of the oil spill detection problem is to distinguish oil slicks from other natural phenomena (look-alikes) that create dark patches in the SAR image. The project approach was divided into detecting dark areas, extracting features for all dark areas, and then classifying spots as oil spills or look-alikes. This paper addresses the classification step. In the literature, various classifiers have been applied to classify a slick as oil or look-alike, but the studies are performed on different data sets and are based on different methodologies; hence, the results are not directly comparable. The first results are presented from a study on classifiers applied to ENVISAT ASAR images. First, based on the basic classifier, classification performance has been improved by introducing regularization of the covariance matrices. Second, the statistical classifier is compared with Support Vector Machines and Neural Network techniques. A prior distribution and a probability density for the features have been combined through Bayes theorem to obtain the posterior probability for a detected spot being an oil slick. Within each level of wind, both the oil slicks and the look-alikes can vary in shape and other features, and so describing the feature density by a unimodal density such as the Gaussian is not appropriate. Different densities depending on the value of a shape descriptor and the wind level are assumed. The wind level (w) is first used to divide the samples in two different subclasses that are further divided into five subclasses based on the shape descriptor (g). The densities within each subclass are assumed Gaussian. Equal diagonal covariance matrices for the oil slick subclass and its corresponding look-alike subclass were used because the look-alike classes had many times more observations than the oil spill classes, resulting in a large variance bias. A regularization of the common covariance matrices is suggested to adapt the classifier to ENVISAT images. The data set consists of 56 training images and 27 test images. When classification accuracy on the test set using common diagonal covariance matrices

vs. common regularized covariance matrices was compared, the number of correctly detected look-alikes increased from 80 to 87%, while the number of correctly detected oil spills was nearly unchanged, decreasing from 78 to 77%.

Characterization on Dioxin Emission of TiO₂ Nanoparticle-Encapsulating Poly(Vinyl Chloride) (TEPVC) Compared to Conventional PVC

Yoo, H., S.H. Kim, A.R. Lee, and S.-Y. Kwak, Seoul National Univ., KR

Nanotech 2007: Technical Proceedings of the 2007 NSTI Nanotechnology Conference and Trade Show. Nano Science & Technology Institute (NSTI), ISBN: 1-4200-6183-6, Vol 2, p 598-601, 2007

The present study measures and compares the amount of dioxin emitted from both TiO₂ nanoparticle-encapsulating poly(vinyl chloride)TEPVC and PVC incineration, and estimates the dioxin inhibition efficiency of TEPVC. The TEPVC and PVC samples were combusted at 700° C. The off gas was trapped using a sequentially placed thimble filter, water and diethylene glycol impingers in a cold-bath, and amberlite XAD-2 resin absorption tubes. Following extraction, samples were spiked with internal standards, and put through a multi-layer silica-gel and alumina columns. Results from HRGC/HRMS analysis for TEPVC showed reduced dioxin emission that was attributed to the enhanced dispersibility of TiO₂ nanoparticles by nanoparticle encapsulation.

Comparison of Water Quality Profiles from Shallow Monitoring Wells and Adjacent Multilevel Samplers

Metcalf, Meredith J. and Gary A. Robbins.

Ground Water Monitoring & Remediation,
Volume 27 Issue 1 Page 84-91, Winter 2007

This study compared water quality profiles taken within the screened interval of five shallow monitoring wells and those obtained from adjacent multilevel sampler clusters. The parameters measured were oxidation-reduction potential, electrical conductivity, temperature, methyl tertiary-butyl ether (MTBE) concentrations, and chloride concentrations. The monitoring wells contained relatively constant values for the measured parameters and chemicals throughout the screened interval while there were large variations observed with depth in the discrete samplers. The results suggest that sampling conventional shallow monitoring wells with active or passive samplers at different depths within a well screen may not provide an accurate indication of how constituents may vary in the adjacent formation with depth.

Coupling Passive Air Sampling with Emission Estimates and Chemical Fate Modeling for Persistent Organic Pollutants (POPs): A Feasibility Study for Northern Europe

Gioia R, A.J. Sweetman, and K.C. Jones

Centre for Chemicals Management, Department of Environmental Science, Lancaster Environment Centre, Lancaster University, Lancaster, LA1 4YQ, UK.
Environ Sci Technol. 2007 Apr 1;41(7):2165-71

Using passive air samplers, this study collected air contaminants at 23 locations in eight northern European countries. The samplers were analyzed for PCBs, PBDEs, PAHs, and a range of organochlorine pesticides. The highest levels of PCBs and PAHs were in Denmark and lowest in northern Norway. Hexachlorobenzene (HCB) concentrations were relatively uniform across all countries. Concentrations of polybromated diphenyl ethers (PBDE) were generally similar at

all sites, except for some locations in Eastern Europe and Ireland where they were lower. The results for PCBs, HCB, and PBDEs were compared to those from a multi-media chemical fate emissions model using other data. This exercise was instructive for there were some compounds such as PCBs in the UK where the national inventory gave predicted air concentrations in close agreement with those measured while in other areas the national inventory seriously underestimated the measured concentrations (e.g., PCBs in Norway). The underestimation in Norway is likely caused by PCB migration from sources outside the country. HCB was consistently underestimated by the emissions models. The paper gives guidelines for countries that want to assess their POPs source inventories using this relatively cheap initial screening approach.

Daytime Rapid Detection of Minerals and Organics from 50 and 100 M Distances Using a Remote Raman System

Misra, A.K., S.K. Sharma, P.G. Lucey, R.C. F. Lentz, and C.H. Chio

Lidar Remote Sensing for Environmental Monitoring VIII.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6681, 2007

A remote Raman system has been developed using an 8-in telescope and a 532-nm pulse laser (20 Hz and 20 mJ/pulse). This system is capable of operating in daylight, and good quality Raman spectra with high signal-to-noise ratios were readily obtained at distances of 50 and 100 m at an integration time of just 1 second (equivalent to 20 laser pulses at 20 Hz). The Raman system also was tested using only single-laser-pulse excitation (8 ns pulse width) with an integration time of 2 μ s. The spectra obtained from single-laser-pulse excitation also show clear Raman features and can be used for rapid, unambiguous identification of various chemical substances. Substances successfully identified include organic chemicals (acetone, naphthalene, nitromethane, nitrobenzene, and cyclohexane), inorganic chemicals and minerals (nitric acids, sulfuric acid, potassium perchlorate, gypsum, ammonium nitrate, epsomite, melanterite, calcite, and sulfur), and amino acids. The remote Raman system is suitable for applications in environmental monitoring or homeland security.

Derivation of New Emission Factors for Quantification of Mass Emissions When Using Optical Gas Imaging for Detecting Leaks

Lev-On, M. (LEVON Group, LLC, Thousand Oaks, CA); D. Epperson; J. Siegell (ExxonMobil Research and Engineering Company, Fairfax, VA); K. Ritter (API, Washington, DC).

Journal of the Air & Waste Management Association, Vol 57 No 9, Sep 2007

New "leak/no leak" emission factors suitable for estimating facility fugitive emissions have been developed based on optical gas imaging technology for detecting leaking piping system components. These emission factors were derived for valves, pumps, and connectors/flanges for instrument leak detection thresholds ranging from 3 to 60 g/hr using a combination of field data and Monte Carlo statistical simulation techniques. These newly derived emission factors are designed to replace the U.S. EPA 1995 Protocol factors based on Method 21 emissions leak monitoring. The emission factors published in the 1995 Protocol have not been updated since the 1970s. The use of the newly derived emission factors is demonstrated for different methods of computing fugitive emissions from a hypothetical model refinery. The resulting facility emissions calculated by using these new emission factors is compared with the existing emission estimation methods provided in the EPA 1995 Protocol. The results

demonstrate that the new emission factors provide an emission estimate that is the closest to that obtained from the direct determination of total emissions by Monte Carlo simulations.

Design of an MTBE Remediation Technology Evaluation

Azadpour-Keeley, Ann and Michael J. Barcelona.

Ground Water Monitoring & Remediation,

Volume 26 Issue 2 Page 103-113, Spring 2006

An evaluation of the aquifer was performed as part of a pilot scale bioremediation technology trial for methyl tert-butyl ether MTBE. The natural gradient was studied using bromide as a conservative tracer. The tracer experiment revealed a complex velocity field in terms of vertical stratification and preferential flowpaths. The hydraulic conductivity was found to be much higher in the lower part of the aquifer, which historically has significantly influenced MTBE transport. A second tracer experiment using bromide and deuterated MTBE (D-MTBE) was conducted at the onset of the technology trial and after the aquifer was made aerobic. This experiment showed that D-MTBE also behaved as a conservative tracer; however it behaved differently from that of the existing dissolved MTBE plume. The data imply that the existing MTBE plume data may not provide an understanding of the complexity of the flow field.

Detection of Organophosphorous Nerve Agents Using Liquid Crystals Supported on Chemically Functionalized Surfaces

Cadwell, K.D., N.A. Lockwood, B.A. Nellis, M.E. Alf, C.R. Willis, and N.L. Abbott.

Sensors and Actuators B: Chemical, Vol 128 No 1, p 91-98, 12 Dec 2007

Thin films of the nematic liquid crystal E7 supported on chemically functionalized surfaces were used to indicate the presence of vapors of the organophosphorous nerve agents sarin, soman, tabun, and VX. The surfaces were prepared by the deposition of metal perchlorate salts onto carboxylic acid-terminated self-assembled monolayers. When using surfaces prepared from aluminum perchlorate salts, the nematic film of E7 underwent a transition from a perpendicular orientation to a tilted or planar orientation upon exposure to vapors of sarin, soman, tabun, or VX generated from a small drop of agent placed on a piece of filter paper. The transition in the orientation of the liquid crystal was readily apparent as an optical signal visible to the naked eye. The agent VX, which has the lowest vapor pressure of these organophosphorous nerve agents (~140 ppb), was reported by the liquid crystal within 60 seconds. Sarin, soman, and tabun, which have higher vapor pressures, triggered responses in the liquid crystal that were evident within 15, 15, and 60 seconds, respectively. By preparing surfaces from perchlorate salts of aluminum(III), zinc(II) and iron(III), it was possible to distinguish between sarin, VX, and either soman or tabun, thus demonstrating the feasibility of designing surfaces patterned with metal salts to detect and identify chemical warfare agents.

Development of Bespoke Bioluminescent Reporters with the Potential for In Situ Deployment Within a Phenolic-Remediating Wastewater Treatment System

Wiles, Siouxsie, Andrew S. Whiteley, Jim C. Philp, and Mark J. Bailey.

Journal of Microbiological Methods, Vol 55 No 3, p 667-677, Dec 2003

Four *Pseudomonas* species were engineered to carry a stable chromosomal copy of the lux operon (luxCDABE) derived from *Photobacterium luminescens*. These recombinant reporter

microorganisms were tested for bioluminescence response to relevant phenol concentrations in the laboratory and to effluents generated by an industrial wastewater treatment plant. The reporters displayed proportional responses of bioluminescence decay with increasing phenol concentrations up to 800 mg/L of phenol. When deployed against wastewater samples, they showed operational range and sensing capabilities superior to those observed for industry standard microorganisms, such as *Vibrio fischeri*. The engineered strains accurately predicted toxicity shifts in all the treatment compartments under study (with phenolic concentrations ranging from ~10 to 600 mg/L). These results highlight the utility of genetically modifying site-specific microorganisms to provide robust organism-based reagents for toxicity monitoring with the potential for in situ deployment.

Direct and Indirect Contribution of Microbial Metabolic Byproducts to the Electrical Properties of Porous Media

Davis, C.A., E.A. Atekwana, and E.A. Atekwana (Univ. of Missouri-Rolla); L.D. Slater (Rutgers Univ., Newark, NJ); B.H. Wagner (Univ. of Missouri-Rolla).

Eos: Transactions of the AGU, Vol 87 No 36, Jt. Assem. Supplement, Abstract NS41A-02, 2006

Organic acids and biosurfactants are common intermediates of microbial mineralization of organic carbon in natural environments, and both have the potential to affect electrical measurements by contributing directly to the ionic strength of an aqueous solution. Organic acids impact electrical measurements indirectly by mineral dissolution, which increases the pore water conductivity and/or secondary porosity. Laboratory sand-packed column experiments were designed to simulate the effect of common microbial metabolic byproducts on electrical measurements. Researchers collected low-frequency (0.1-1000 Hz) electrical measurements of silica sand-packed columns saturated with organic acids or biosurfactants of varying concentration. The electrolytic (bulk and fluid) conductivity increased with increasing concentrations of organic acids or biosurfactants, while the interfacial (imaginary) conductivity remained relatively steady. The contribution to ionic strength by dissolution by organic acids was also investigated by collecting low-frequency electrical measurements on natural sand-packed columns saturated with organic acids for a period of 120 days. Both columns saturated with organic acid and tap water showed a steady increase in the imaginary, real, and fluid conductivities for the first 60 days, after which the organic acid and tap water columns appeared to reach equilibrium in the electrical parameters and remained relatively constant for the duration of the experiment. The similar trend in both acid and tap water-treated columns suggests that increases in electrical parameters and pH are enhanced by more than the presence of organic acids. The results of this study show that although the direct presence of metabolic byproducts increased the real conductivity, the change in the imaginary conductivity was negligible. The dissolution experiment showed higher real and imaginary conductivity with time, consistent with increases in the ionic strength of the fluid and enhancement of polarization in the sands.

Direct Determination of Free Cyanide in Drinking Water by Ion Chromatography with Pulsed Amperometric Detection

Christison, Terri T. and Jeffrey S. Rohrer, Dionex Corporation, Sunnyvale, CA/

Journal of Chromatography A, Vol 1155 No 1, p 31-39, 29 June 2007

For determination of free cyanide in drinking water, samples are treated with sodium hydroxide to stabilize cyanide and with a cation-exchange cartridge to remove transition metals.

Cyanide is separated by anion-exchange chromatography and detected by pulsed amperometric detection with a waveform optimized for cyanide and used with a disposable silver working electrode. The method achieved >80% recovery of cyanide spiked into five water samples/ With an MDL of 1.0 ug/L, this method determines cyanide concentrations well below the reporting limits for free cyanide in drinking water.

Disposable Sensor Uses DNA to Detect Hazardous Uranium Ions University of Illinois News Release, 13 Feb 2007

Researchers at the University of Illinois at Urbana-Champaign have developed a simple, disposable sensor for detecting hazardous uranium ions, with sensitivity that rivals the performance of much more sophisticated laboratory instruments. The sensor provides a fast, on-site test for assessing uranium contamination in the environment, as well as the effectiveness of remediation strategies. According to Yi Lu, a chemistry professor at Illinois, a unique feature of the uranium sensor is that it contains a small piece of DNA. The sensor combines the high metal ion selectivity of catalytic DNA with the high sensitivity of fluorescence detection. While most DNA is double stranded, the catalytic DNA used by Lu's research group has a single-strand region that can wrap around like a protein. In that single strand, the researchers fashion a specific binding site, a kind of pocket that can accommodate only the metal ion of choice. The researchers chose to detect uranyl, the most soluble species of uranium ion and the one that poses the greatest threat to human life. To search for the unique sequence of DNA that could distinguish uranyl from other metal ions, the researchers used in vitro selection, a combinatorial approach. The simple and cost-effective selection process can sample a very large pool of DNA (up to 1,000 trillion molecules), amplify the desired sequence by the polymerase chain reaction, and introduce mutations to improve performance. With collaborators at Illinois, the USACE Construction Engineering Research Laboratory, Oregon State University, and Oak Ridge National Laboratory, Lu assembled the uranium sensor and tested it on soils containing varying amounts of uranium. The presence of uranyl causes catalytic cleavage of the DNA and release of the fluorophore, resulting in a dramatic increase of fluorescence intensity. With a detection sensitivity of 11 parts per trillion, the disposable sensor rivaled the performance of much more sophisticated laboratory instruments. In 2000, Lu's research group used the same catalytic DNA process to create a simple but effective lead sensor. Their success demonstrates that the methodology can be used to make cost-effective sensors for other hazardous metals, with extremely high sensitivity and selectivity. The technology also can be used to construct sensor arrays that detect and quantify many metal ions simultaneously. Contact: Yi Lu, 217-333-2619; yi-lu@uiuc.edu.

Diurnal-Scale Groundwater Potentiometric Fluctuations—a Possible Aquifer Characterization Tool

Johnson, Ken

Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007. p 118, 2007

An examination of water level measurements taken at 15 minute time intervals in a former supply well revealed consistent fluctuations in the water levels. There was an approximately 12-hour wave-length component in the data that argued against its being caused by evapotranspiration from nearby vegetation and there were no domestic wells located nearby.

The cyclical part of the fluctuation is probably related to atmospheric barometric pressure, which is in turn related to solar heating of the atmosphere. This barometric phenomenon can be used as a naturally-occurring aquifer stressor that may affect water levels through the mediation of the "barometric efficiency" of the aquifer.

Effective Anion Sensing Based on the Ability of Copper to Affect Electron Transport Across Self-Assembled Monolayers

Ganesh, V., M.P. Calatayud Sanz, and J.C. Mareque-Rivas, Univ. of Edinburgh, UK.

Chemical Communications, Vol 47, p 5010-5012, 21 Dec 2007

The ability of copper ions to affect the charge-transfer resistance of self-assembled monolayers (SAMs) of a tris-(2-pyridylmethyl)amine-based ligand on to gold electrodes has been used to create a sensitive and selective electrochemical cyanide sensor.

Electrical Monitoring of In Situ Chemical Oxidation by Permanganate

Cave, L., N. Hartog, T. Al, B. Parker, K.U. Mayer, and S. Cogswell.

Ground Water Monitoring & Remediation, Vol 27 No 2, p 77-84, Spring 2007

An array of electrical monitoring probes was constructed to monitor a concentrated permanganate solution injected to treat PCE contamination in a shallow sandy aquifer. The simple probes comprise pairs of stainless steel wires as electrodes for electrical conductivity (EC) and platinum wires as the working electrodes for oxidation-reduction potential (ORP) measurements. Combined EC/ORP probes were assembled into bundles with multilevel groundwater samplers and installed in boreholes around the injection point. Copper/copper sulfate half-cells inserted to the depth of the water table acted as ORP reference electrodes. A central data acquisition system collected data for 25 days following the injection. Based on the contrasts in the EC and ORP characteristics of the groundwater compared with those of the permanganate solution, the relatively simple electrical measurements were used to track the subsurface migration of permanganate. The electrical data tracked the arrival times of the permanganate at discrete positions in the aquifer, which allowed visualization of permanganate distribution during destruction of PCE and guided the timing and selection of locations for water sampling.

Electrical Resistivity Tomography Applied to Geologic, Hydrogeologic, and Engineering Investigations at a Former Waste-Disposal Site

Chambers, J.E., O. Kuras, P.I. Meldrum, and R.D. Ogilvy (British Geological Survey, Keyworth, Nottingham, UK); J. Hollands (North Lanarkshire Council, Cumbernauld, UK).

Geophysics, Vol 71 No 6, p B231-B239, Nov-Dec 2006

A former dolerite quarry and landfill site were investigated using 2D and 3D electrical resistivity tomography (ERT) to determine buried quarry geometry, map bedrock contamination arising from the landfill, and characterize site geology. Resistivity data were collected from a network of intersecting survey lines using a Wenner-based array configuration. Integration of the 3D spatial analysis of the ERT and conventional site investigation data provided a highly effective means of characterizing the landfill and its environs. The 3D resistivity model was used to confirm the position of the landfill boundaries, which appeared as electrically well-defined features that corresponded closely to both historic maps and intrusive site investigation data. A potential zone of leachate migration from the landfill was identified from the electrical models;

the location of this zone was consistent with the predicted direction of groundwater flow across the site.

Electromagnetic Detection and Digital Visualization of DNAPL Contaminants in a Two-Dimensional Soilbed

Serrano, M.F., I.Y. Padilla, and R. Rodriguez, Univ. of Puerto Rico, Mayaguez.

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract B41B-09, 2007

Cross-well radar (CWR) is a semi-noninvasive technique that allows changes in electromagnetic properties to be detected when materials of different dielectric characteristics are present in underground environments, which has led researchers to investigate use of the technology for locating and monitoring contaminants (particularly DNAPLs) of differing dielectric properties in the subsurface. Validation of this technology to detect, image, and monitor DNAPL distribution under variable saturation and flow conditions is conducted through powerful image analysis techniques, which can discriminate between regions of different amounts of contaminants. The project involves placing transmitting and receiving loop antennas in a 2D SoilBed at preset locations and measuring their transmission and reflection characteristics in the presence and absence of DNAPLs. Simultaneous acquisition of visible images is taken with a camera. Antenna response is compared with colorimetric indices developed for different mass concentrations. A 2D SoilBed system has been developed to evaluate two modes of concurrent detection and monitoring technologies: CWR and image analysis (IA). Both technologies are applied concurrently in the SoilBed system during DNAPL transport experiments. Variations in electromagnetic (EM) waves are detected in the presence of contaminants, while color images are acquired. EM signal processing and IA algorithms are being developed to establish the relation between electrical soil properties variations and changes in the spatial and temporal mass of contaminants.

Encapsulation of Organophosphorus Acid Anhydrolase (OPAA) in Nanostructured Materials for the Detection and Decontamination of Chemical Warfare Agents

Ong, Kate K., Ph.D. dissertation, Drexel University, 235 pp, 2006

Organophosphorus acid anhydrolase (OPAA) was encapsulated into silica and organically modified silica materials using acid-catalyzed hydrolysis and co-condensation of tetramethylorthosilicate and organosiloxanes via the non-surfactant templated sol-gel process. The pore forming template was prepared using either D-fructose or poly(ethylene glycol). By varying the template concentration or the concentration of the starting materials, a high surface area of 500 to 800 m²/g and a large pore volume ranging from 0.2 to 0.8 cm³/g can be obtained. OPAA denaturation by organic solvents was significantly decreased by its immobilization in the mesoporous materials. A simple regeneration procedure involving buffer wash resulted in the encapsulated samples retaining activity after several reuses with little or no indications of enzyme leakage. The detection limit obtained using this method for cyanide was 1 ppm. The experiment results indicate that biomolecules, such as OPAA, can be entrapped into mesoporous materials via the nonsurfactant templated pathway. Dissertation at http://dspace.library.drexel.edu/bitstream/1860/895/1/Ong_Kate.pdf

Environmental and Compound-Specific Stable Isotopes: Geochemical Forensic Tools with Application to Site Characterization in a Complex Hydrogeologic Situation

Vlassopoulos, Dimitri, Mark Conrad, Michael J. Riley, Terry Belunes, and Patty Boyden
Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007

This paper discusses the use of isotopes (oxygen, hydrogen, and carbon) to determine groundwater flow direction, aquifer discharge and recharge zones, and the sources related to a volatile organic compound (VOC) plume in the vicinity of the Port of Vancouver, WA. There are three known sources of VOCs in the area but their individual contributions to the overall plume are difficult to ascertain. The current conceptual model indicates that contaminant plumes originating from the three source areas are being drawn towards a nearby industrial production well field that is adjacent to the Columbia River. The model also postulates that the production wells are drawing water from the river. Stable ($\delta^{18}\text{O}$) and (δD) isotope ratios of groundwater and compound-specific stable carbon isotope ratios ($\delta^{13}\text{C}$) of TCE and PCE were determined to provide evidence in support of the site conceptual model and to verify model predictions regarding origins of water (river vs precipitation recharge) and sources and commingling of VOC plumes. The isotope signatures enabled a clear distinction to be made between river water and precipitation and allowed maps showing the areas recharged by river water to be drawn. Multivariate VOC signatures, in combination with compound-specific $^{13}\text{C}/^{12}\text{C}$ ratios of TCE and PCE, provided unique and distinguishable contaminant fingerprints that show the downgradient transport, transformation, and commingling of VOCs from the three source areas. This analysis greatly aided in the refinement of the site conceptual model, provided independent verification of the numerical model, and provided a quantitative basis for apportioning cost allocation among the three sources.

Equivalent Leak Definitions for Smart LDAR (Leak Detection and Repair) When Using Optical Imaging Technology

Epperson, D., M. Lev-On, H. Taback, J. Siegel, and K. Ritter.

Journal of the Air & Waste Management Association, Vol 57 No 9, p 1050-1060, July 2007

Controlling fugitive emissions from leaks in petrochemical industry process equipment now requires periodic monitoring of valves, flanges, pumps, etc., typically on a quarterly basis. Over 90% of the reducible emissions have been shown to come from ~0.1% of the components (the "large leakers"). A more cost-effective approach for controlling these large leaks—"smart LDAR"—entails more frequent monitoring of process equipment, allowing for the detection and repair of the highly leaking components that contribute the most to emissions. New optical imaging instruments, which significantly reduce monitoring costs, are now available to implement such an alternative work practice. This paper describes the determination of the leak detection sensitivity (equivalency threshold) that an optical imaging instrument must achieve to ensure that it will provide at least the equivalent emission control of the current leak detection and repair practice.

Evaluation of Fugitive Emissions Using Ground-Based Optical Remote Sensing Technology
U.S. EPA, National Risk Management Research Laboratory, Research Triangle Park, NC.
EPA 600-R-07-032, 111 pp, Feb 2007

EPA has developed and evaluated a method for characterizing fugitive emissions from large area sources. The method, known as radial plume mapping (RPM), uses multiple-beam, scanning, optical remote sensing (ORS) instrumentation, such as open-path Fourier transform infrared spectroscopy, ultraviolet differential absorption spectroscopy, open-path tunable diode spectroscopy, and open-path tunable diode laser absorption spectroscopy in unique radial configurations and optimization algorithms providing essential spatial data for emission calculations. The RPM method can be used for characterizing emissions from a wide range of area sources, including landfills, wastewater treatment plants, and agricultural operations. This report represents a three-year effort conducted to evaluate the feasibility of using ORS instrumentation to measure landfill gas emissions, which include methane, volatile organic compounds, and air toxics. <http://www.epa.gov/nrmrl/pubs/600r07032/600r07032.htm>

Evaluation of the Snap Sampler for Sampling Ground Water Monitoring Wells for VOCs and Explosives

Parker, Louise V. and Nathan D. Mulherin, Cold Regions Research and Engineering Lab, U.S. Army Engineer Research and Development Center, Hanover, NH.
ERDC/CRREL TR-07-14, 68 pp, Aug 2007

Laboratory and field studies were conducted to determine the ability of the Snap Sampler to recover representative concentrations of VOC and explosives in ground water. For the laboratory studies, statistical analyses of the data were conducted for each analyte to determine if the concentrations of analytes in samples taken with the Snap Sampler were significantly different from known concentrations of the analytes in samples collected from a standpipe (i.e., control samples). For the field studies, concentrations of analytes in samples taken with the Snap Sampler were compared with concentrations of the analytes in samples taken using EPA's low-flow purging and sampling protocol. Again, statistical analyses were used to identify any statistically significant differences between the individual analyte concentrations in these samples. Two field trials were conducted for VOCs and one for explosives. In the laboratory studies, the Snap Sampler recovered concentrations of VOCs comparable to those in the control samples after equilibrating the Snap Sampler for three days. Comparable concentrations of explosives were recovered after equilibrating the Snap Sampler for 24 hours. In the field studies, concentrations of VOCs and explosives were comparable to concentrations of the analytes in samples collected using low-flow purging and sampling.

<http://www.crrel.usace.army.mil/library/technicalreports/ERDC-CRREL-TR-07-14.pdf>

Feasibility of Landmine Detection Using Transgenic Plants

Deyholos, M., A.A. Faust, M. Miao, R. Montoya, and D.A. Donahue.

Detection and Remediation Technologies for Mines and Minelike Targets XI.

Proceedings of SPIE -- The International Society for Optical Engineering, Volume 6217, 2006

Two approaches are described that are designed to increase the potential effectiveness of TNT detection by plants and microorganisms: (1) DNA microarray experiments are being conducted with plants treated with TNT-degradation products to expand the repertoire of explosive-responsive promoters, with characterization of the inducibility of reporter gene

expression by these promoters, and (2) the dynamics and limiting factors in the transmission of artificial signals from roots to shoots are being determined. These studies will increase the ability of soil-based TNT perception strategies to effect human-readable changes in shoot morphology as part of a practical plant-based explosives detection system.

Fiberoptic Diisocyanate Personal Monitoring Device

Lis, Steven A.

Advanced Environmental, Chemical, and Biological Sensing Technologies IV.

Proceedings of SPIE -- The International Society for Optical Engineering, Volume 6377, 2006

Occupational exposure to diisocyanates has been linked to asthma-like symptoms and is a significant occupational concern requiring employee personal monitoring devices that are sensitive and accurate in the ppb range. A novel design fiber optic chemical sensor has demonstrated sensitivity of 0.2 ppb for a 20-minute exposure in air for multiple isocyanate species. Sensor response is very linear over the range of 0 to 25 ppb. The sensor is based on a novel, long-fiber evanescent wave design that provides high sensitivity while maintaining low materials cost. Sensitivity to interference by humidity is modest. Sensor packaging can be directly compatible for passive use in personal monitoring. The sensor is reusable, simple and inexpensive to fabricate, and easily processed by the user in a nearly all dry process in an automated instrument. Highly quantitative sensor response is provided by a unique data analysis process that is readily automated and provides high linearity over a range applicable to sensing needs.

Field Demonstration and Validation of a New Device for Measuring Water and Solute Fluxes at CFB Borden

Hatfield, Kirk, Michael D. Annable, and P.S.C. Rao.

Environmental Security Technology Certification Program (ESTCP), Project CU-0114, NTIS: ADA468536, 153 pp, Nov 2006

The use of contaminant flux and contaminant mass discharge as robust metrics for assessment of risks at contaminated sites and for performance evaluation of site remediation efforts has gained increasing acceptance within the scientific, regulatory, and user communities. The acceptance and use of innovative technologies is slow and gradual within the environmental community, requiring both a sound theoretical basis accepted widely in technical circles and field-scale demonstration at diverse sites. In 2001, ESTCP funded Project CU-0114 to demonstrate and validate a new monitoring technology: the passive flux meter (PFM). This device provides direct in situ measurements of both subsurface water and contaminant fluxes. The focus of the project was to demonstrate and validate the PFM for simultaneous measurement of the ground water and contaminant fluxes in contaminated aquifers. This report presents results of PFM demonstration/validation from a series of controlled field experiments conducted at the Canadian Forces Base Borden Demonstration Site in Ontario, Canada.

<http://handle.dtic.mil/100.2/ADA468536>

Field Demonstration and Validation of a New Device for Measuring Water and Solute Fluxes at Naval Base Ventura County (NBVC), Port Hueneme, CA: Revised Final Report (Version 2)
Hatfield, K., M.D. Annable, and P.S.C. Rao.
Environmental Security Technology Certification Program (ESTCP), Project CU-0114, 113 pp, July 2006

The passive flux meter (PFM) is a new technology that directly addresses DoD's need for cost-effective long-term monitoring based on the utility of contaminant flux measurements for process control, remedial action performance assessments, and compliance purposes. Under ESTCP project ER-0114, the PFM was demonstrated and validated at several locations. At Naval Base Ventura County (NBVC), Port Hueneme, CA, groundwater and contaminant fluxes were measured using PFMs at the leading edge of a methyl tert-butyl ether (MTBE) plume. The objectives of PFM deployment at the NBVC site were to demonstrate the validity of the PFM and to compare flux measurements in wells reflecting different designs or construction techniques. The PFM demonstrations are designed to gather field data in support of an effort to transition the technology from the innovative testing phase to a point of regulatory and end user acceptance and, eventually, commercialization. Based on the demonstration results, further investigation is warranted that will lead to improved methods for quantifying in situ flow convergence factors. These factors serve a critical role in the interpretation of PFM results, and they are expected to vary between well types and aquifer conditions, as was the case at NBVC. A facile independent method for determining flow convergence factors a priori would facilitate PFM implementation in the field and its ultimate adoption by the environmental community.
<http://handle.dtic.mil/100.2/ADA468560>

Field Demonstration and Validation of a New Device for Measuring Groundwater and Perchlorate Fluxes at IHDIV-NSWC, Indian Head, MD: Final Report (version 2)
Hatfield, K., M.D. Annable, and P.S.C. Rao.
Environmental Security Technology Certification Program (ESTCP), Project CU-0114, 138 pp, July 2006

The use of innovative technologies can be slow to gain acceptance in the environmental community until a sound theoretical basis has been accepted widely in technical circles and the effectiveness of the technology has been demonstrated at field scale at diverse sites. Under ESTCP project ER-0114, the passive flux meter (PFM) was demonstrated and validated at several locations. Because the other field applications were conducted at sites with dense or light nonaqueous-phase liquids, the demonstration at Indian Head Naval Surface Warfare Center (IHDIV-NSWC) in Maryland applied the PFMs to the measurement of water and perchlorate contaminant fluxes. The field studies conducted at IHDIV-NSWC demonstrated the applicability of a new PFM sorbent, SM-SI-GAC, for field-scale measurement of groundwater and perchlorate fluxes. The measured fluxes showed good reproducibility between two deployments and also compared well with borehole dilution tests and conventional ground-water monitoring data. The results indicated that SM-SI-GAC can be used as a PFM sorbent in sites with perchlorate concentrations ranging from 7 to 64 mg/L. The results also showed the SM-SI-GAC was stable physically, chemically, and biologically for a maximum of 44 days and the alcohol tracers and captured perchlorate on it were not biodegradable. This report also describes the results of laboratory efforts to extend the use of the PFM technology to assess contaminant fluxes at sites with inorganic anions (e.g., chromate, selenate, arsenate, phosphate, and nitrate) and organic

acids that could serve as electron donors in bioremediation (e.g., lactate, citrate, benzoate, and phenols). <http://handle.dtic.mil/100.2/ADA468561>

Field Evaluation of Digital Optical Method to Quantify the Visual Opacity of Plumes

Du, K., M.J. Rood, B.J. Kim, M.R. Kemme, B.J. Franek, K. Mattison, and J. Cook.

Journal of the Air & Waste Management Association, Vol 57 No 7, July 2007

U.S. EPA Method 9, Visual Determination of the Opacity of Emissions from Stationary Sources, is a reference method to quantify plume opacity. Because Method 9 relies on human observation, quantification is based on a subjective assessment. Field tests were completed during a "smoke school" and a 4-month program to monitor plumes emitted from stationary sources with (1) a Method 9-qualified observer to evaluate the use of digital photography and (2) two computer algorithms as an alternative to Method 9. The digital optical method (DOM) improves objectivity, costs less to implement than Method 9, and provides archival photographic records of the plumes. Results from the smoke school tests indicate that DOM results were largely dependent on the sector in which the sun was located relative to the three cameras at the time the photo was taken. Certification to read plume opacity by a smoke reader for 6 months requires that the smoke reader pass one of the smoke school tests during training. The average opacity errors and percentage of observations with individual opacity errors above 15% for the results obtained with DOM were lower than those obtained by the smoke school trainees when the sun was located behind the camera, whereas they were higher than the smoke school trainee results with the sun located in front of the camera. As measured in the field for two industrial sources, the difference between plume opacity values obtained by DOM and a Method 9-qualified observer were 2.2%. These results indicate that digital photography is an appropriate means to quantify plume opacity and has the potential to serve as an alternative to Method 9 for determining the opacity of plumes that are emitted from elevated point sources.

Field Test Measurements at Five Municipal Solid Waste Landfills with Landfill Gas Control Technology (Final Report)

U.S. EPA, National Risk Management Research Laboratory, Research Triangle Park, NC.

EPA 600-R-07-043, 65 pp + 5 separate appendices, Apr 2007

The objective of this project was to collect and provide current data from U.S. MSW landfills with state-of-the-art control technology used for reducing landfill gas emissions. Comprehensive testing was conducted of the raw landfill gas and the combustion outlet exhaust. The data will be used to help develop emission factors for use in updating EPA's AP-42 for estimating uncontrolled emissions from MSW landfills and combustion byproduct emissions. Pollutants of concern include methane; VOCs; persistent bioaccumulative toxics, such as mercury; and hazardous air pollutants, such as benzene, vinyl chloride, and methyl ethyl ketone. The data will also be used to supplement AP-42 and to provide QA to data previously supplied by industry and others as part of the AP-42 update.

<http://www.epa.gov/ORD/NRMRL/pubs/600r07043/600r07043.htm>

Fusion of Quickbird Satellite Images for Vegetation Monitoring in Previously Mined Reclaimed Areas

Ieronimidi, E., S.P. Mertikas, and D. Hristopoulos, Technical Univ. of Crete, Greece.

Remote Sensing for Environmental Monitoring, GIS Applications, and Geology VI.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6366, 2006

The progress of vegetation growth on reclaimed, previously mined land was monitored using remotely sensed images. Quickbird multispectral and panchromatic images were fused to obtain an optimal combination of the initial spatial and spectral resolution using the blue, green, and near-infrared bands of the multi-spectral image. Different fusion methods—principal component analysis, the intensity-hue-saturation technique, and wavelet analysis—have been applied to the available images. Both statistical (correlation coefficient, accuracy measures, entropy) and subjective (visual) measures have been used to evaluate the produced fused images. The wavelet analysis was found to preserve most of the spectral information of the original multi-spectral image, while principal component analysis retains most of the spatial information of the panchromatic image, and the intensity-hue-saturation technique offers a compromise between the spectral and spatial content of the fused image. The results have been used effectively for environmental monitoring of the reclaimed mine land.

Field Test Results of Standoff Chemical Detection Using the FIRST

Spisz, T.S., P.K. Murphy, C.C. Carter, A.K. Carr, A. Vallieres, and M. Chamberland.

Chemical and Biological Sensing VIII.

Proceedings of SPIE -- The International Society for Optical Engineering, Volume 6554, 2007

The FIRST is a commercial hyperspectral imager developed by Telops. This sensor provides hypercubes of spectral radiance of up to 320x256 pixels at 0.35mrad spatial resolution over the 8 - 12 μm spectral range at user-selectable spectral resolutions of up to 0.25/cm. The measurements are converted into "chemical maps" with algorithms that use both spatial and spectral information. The FIRST has been deployed in several field tests for the standoff detection and identification of chemicals. The sensor usually is operated at 4/cm spectral resolution, and the image size is tailored according to the dissemination. Algorithms based on a combination of clutter-matched filters and a spectral angle mapper have been developed and used to process the measured data. The algorithms combine sub-band selection to minimize the correlation between the spectral signatures in the library and careful selection of the thresholds to reduce the level of false alarms. The output of the algorithms is the image of the clouds superimposed on the broadband thermal image. The algorithm combines background/noise suppression techniques, spectral detection techniques, and automatic adaptive threshold techniques. This paper presents the successful standoff detection and identification of different chemical compounds using a variety of field measurements. Images of chemical disseminations are presented, including mixtures of two different chemicals.

Gas Detection Using an Integrating Sphere as a Multipass Absorption Cell

Hawe, E., G. Dooly, P. Chambers, C. Fitzpatrick, and E. Lewis.

Photonic Applications for Aerospace, Transportation, and Harsh Environments.

Proceedings of SPIE -- The International Society for Optical Engineering, Volume 6379, 2006

This paper describes a multipass absorption cell used to detect and monitor the presence of several gases in the UV and visible regions. An integrating sphere with a highly reflective

internal coating (over 99%) was adapted for input and output of various gases. Sulfur dioxide was detected in the UV region, ozone in the visible, and nitrogen dioxide in both the UV and visible. Effective optical path lengths of up to 70 cm have been generated using an integrating sphere 5 cm in diameter. The optical sensor is capable of detecting sulfur dioxide concentrations as low as 10 ppm, nitrogen dioxide concentrations as low as 4 ppm, and ozone levels on the order of 500 ppm.

Geochemical Characterization of Mine Waste, Mine Drainage, and Stream Sediments at the Pike Hill Copper Mine Superfund Site, Orange County, Vermont

Piatak, N.M., R.R. Seal II, J.M. Hammarstrom, R.G. Kiah, J.R. Deacon, M. Adams, M.W. Anthony, P.H. Briggs, and J.C. Jackson.

U.S. Geological Survey, Scientific Investigations Report 2006-5303, 120 pp, 2006

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

<http://pubs.usgs.gov/sir/2006/5303/>

Geoelectrical Signatures of Microbial Stimulated Mineralization

Personna, Y.R., D. Ntarlagiannis, L. Slater, and M. O'Brien (Rutgers Univ., Newark, NJ); S. Hubbard and K.H. Williams (Lawrence Berkeley National Lab, Berkeley, CA).

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract NS44A-05, 2007

Non-invasive, high-resolution geophysical methods have been used in the recent years to elucidate system transformations occurring during bioremediation. The authors performed laboratory column experiments to investigate the geoelectrical response of microbe-mediated iron sulfide (FeS) precipitation accompanying stimulated sulfate reduction, a biological technique used to sequester heavy metals in the subsurface. Induced polarization (IP) and self-potential (SP) were employed to monitor the biomineralization process in conjunction with conventional geochemical measurements. The IP data showed significant anomalies associated with ongoing FeS mineralization accompanying microbial activity, and strong SP anomalies developed during the mineralization as a result of the continuous redox state changes following microbially induced mineral formation. Black precipitates accumulated visibly within the column, indicating FeS precipitation, and high H₂S content confirmed the observed geochemical and geophysical data. Overall, the results suggest that the IP and SP methods can be used to monitor the progress of the microbially induced mineralization process associated with the

precipitation of insoluble metal sulfides and indirectly to monitor microbial activity within the subsurface.

Geophysical Characterization of a Cover with Capillary Barrier Effect

Chouteau, M., O. Anterrieu, M. Aubertin, and B. Bussieres, Ecole Polytechnique, Montreal, Canada.

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract NS43A-02, 2007

Covers with capillary barrier effects (CCBE) can be used to limit gas flux into or out of mine waste disposal sites. The hydraulic behavior of this type of cover is influenced by slope inclination, which can induce a local desaturation that is detrimental to its efficiency. Covers usually consist of three layers: a 0.5 m layer of sand used on the bottom as support and a capillary break layer, a fine-grained moisture-retaining layer with a thickness of 0.8 m, and a 0.3 m sand and gravel layer on top for drainage and protection against erosion and evaporation. To provide an effective barrier, the fine-grained layer must remain permanently saturated. When TDR probes are installed to monitor saturation level, the number of probes installed is always too small over the very large area of mine wastes protected by CCBE to lead to a good spatial estimation of water content. In investigations of ways to estimate water saturation changes of the cover using geophysics, modeling shows that changes in water content within the cover will affect GPR and resistivity responses. A survey carried out over the flanks and the top of a large mining waste site located in Northwestern Quebec involved the use of GPR with 200 MHz, 450 MHz, and 900 MHz antennas as well as a Lund resistivity imaging system from ABEM with 0.30 m dipoles to image stratigraphy and water content from surface to 1.7 m depth. Thicknesses of each of the three layers within the cover can be mapped with detail. Correlations with TDR data show that the techniques can be used to estimate saturation conditions within the fine-grained barrier with good lateral resolution. The survey has also allowed a suction break installed within one of the slope profiles to be mapped.

Geophysical Detection of Biomineralization Within Selenium Contaminated Lake Sediment

O'Brien, M., D. Ntarlagiannis, L. Slater, and N. Yee, Rutgers Univ., Newark, NJ.

Eos: Transactions of the AGU, Vol 87 No 36, Jt. Assem. Supplement, Abstract NS41A-05, 2006

In column experiments, geophysical measurements during active selenite reduction were made on lake sediment known to contain indigenous cultures able to precipitate selenium. Electrical geophysical measurements were continually monitored as a selenite medium flowed through columns containing a mixture of Ottawa sand (80%) and sediment (20%). Electrical conductivity of the influent and outflow solutions was also monitored and outflow samples, taken twice a day, were used to determine the selenite concentrations reduced within the column. The sediment/sand mixture within the column exhibited widespread red discoloration within a few days, confirming the microbial reduction of selenite to elemental selenium. The geophysical dataset provided a novel means to ascertain rates of biomineralization within the column and indicated that most of the microbial activity occurred within the first five days of the experiment.

High Chromium Levels in Landfill Monitoring Wells

Huckins, Lee N. Oregon Department of Environmental Quality

Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007

Knott Landfill is located in Bend, Oregon. Bend is a rapidly expanding city and is encroaching on the landfill as land becomes a valuable commodity. Chromium has been detected in the landfill's monitoring wells at concentrations ranging from 0.05 to 0.135 mg/L. Landfill leachate is usually high in total dissolved solids, chloride, alkalinity, iron, manganese, and volatile organic compounds; however this suite of chemicals was not being seen in the monitoring wells. In addition, chromium concentrations in the leachate were ranging from 0.003 mg/L to .021 mg/L. By plotting chemical time series plots a correlation was found between the high chromium levels and elevated concentrations of iron, nickel, manganese and bicarbonate. Nickel, manganese, and chromium are part of the components that make stainless steel. The pump columns within the monitoring wells are made of stainless steel Type 304L and the pump rod ferrals are made of stainless steel Type 316L. The Department and the County pulled one of the monitoring pumps and found that the pump columns were corroding hence it was fair to assume that the chromium in samples taken by the pumps originated in the well not the landfill.

High-Resolution Resistivity Applied to Characterization and Leak Detection at Two Single Shell Tank Farms (SST) at the Hanford Site

Caggiano, Joseph A. WA State Dept. Ecology, Nuclear Waste Program, 3100 Port of Benton Blvd, Richland.

Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007

Hanford's 149 singled-shelled tanks (SSTs) contain saltcake and sludge which is being retrieved and transferred to safer, newer double-shelled tanks (DST). Waste retrieval uses various liquids to dissolve, suspend, and transport the waste to the DSTs. However, the addition of liquids could lead to new waste releases. At least 67 of the SSTs are assumed to have leaked approximately 1 million gallons; thus, leak detection during retrieval is essential to minimize new releases. High resolution resistivity-leak detection and monitoring (HRR-LDM) was selected as a potential leak detection method to monitor the tanks for leaks during the retrieval period. This paper discusses the results of a test of a simulated tank leak, in which 13,500 gallons of waste simulant was injected through a modified drywell. The test indicated that HRR-LDM can detect a leak in a timely manner and give a reasonable approximation of the volume released.

High Sensitivity Near-Field Opto-Chemical Sensors Based on SnO₂ Particle Layers

Consales, M., M. Pisco, A. Buosciolo, R. Viter, V. Smyntyna, A. Cutolo, M. Giordano, and A. Cusano.

Third European Workshop on Optical Fibre Sensors. Proceedings of SPIE—The International Society for Optical Engineering, Volume 6619, 2007

The electrostatic spray pyrolysis method was used to deposit sensing coatings on the distal end of standard fibers. This technique allowed the fabrication of SnO₂ layers composed of micron and sub-micron dimensions able to modify locally the profile of the optical near-field collected in proximity to the fiber tip. The layers' morphology leads to strong surface interactions

between sensing coatings, analyte molecules, and the evanescent contribution of the field, resulting in excellent sensor sensitivity to chemical pollutants, even at room temperature.

Highly Sensitive Detection of Organophosphorus Insecticides Using Magnetic Microbeads and Genetically Engineered Acetylcholinesterase

Istamboulie, G. (Univ. de Perpignan Via Domitia, Perpignan, France); S. Andreescu (Clarkson Univ., Potsdam, NY); J.-L. Marty and T. Noguer (Univ. de Perpignan Via Domitia).
Biosensors and Bioelectronics, Vol 23 No 4, p 506-512, 30 Nov 2007

A new biosensor for organophosphorus pesticides is based on immobilization of a highly sensitive genetically engineered acetylcholinesterase (B394) by affinity interactions on metal chelate-functionalised magnetic microbeads. The new sensor has been compared in tests with sensors based on the widely used electric eel cholinesterase and a classical entrapment procedure in a polyvinylalcohol-based matrix. The oriented and site-specific immobilization combined with the high specificity of the B349 mutant increased sensitivity to insecticides in tests for detection of both chlorpyrifos-oxon and chlorfenvinphos.

Hybrid Control and Acquisition System for Remote Sensing Systems for Environmental Monitoring

Garufi, F., F. Acernese, A. Boiano, R. De Rosa, L. Milano, R. Romano, and F. Barone.
Remote Sensing for Environmental Monitoring, GIS Applications, and Geology VI.
Proceedings of SPIE—The International Society for Optical Engineering, Volume 6366, 2006

The authors describe the architecture and the performance of a hybrid acquisition system prototype deployed in Napoli for remote sensing applications. This system allows the fusion of multi-source data produced by environmental noise sources and is able to integrate geographically distributed sensors for seismic, electromagnetic, acoustic, and other noises sampled at different frequencies. System characteristics and performance are discussed and evaluated for application in a geographically distributed monitoring system.

<http://people.na.infn.it/~garufi/Pubblicazioni/SpieRemoteSensScheda.pdf>

Hydraulic and Tracer Tomography for the Characterization of DNAPL Source Zones: A Laboratory Sandbox Study

Liu, X., W.A. Illman, A.J. Craig, and A. Massi, Univ. of Iowa, Iowa City.
Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract H31F-04, 2007

The main advantage of a characterization approach that employs hydraulic and tracer tomography is that it requires far fewer boreholes than the traditional coring techniques to image the DNAPL source zones. Specifically, it first analyzes the information derived from hydraulic tomography to identify the 3D hydraulic heterogeneity in hydraulic conductivity and specific storage of the aquifer. The newly derived knowledge of heterogeneity is then used to design partitioning tracer tests conducted in a tomographic manner to show the spatial distribution of DNAPL saturations in source zones. The laboratory sandbox studies involved packing aquifers with a deterministic heterogeneity pattern, spilling a known volume of TCE, and subsequently characterizing the spill through hydraulic tomography and tracer tomography, followed by coring at the conclusion of all other tests. The lab results show the viability of imaging DNAPL saturations and estimating their corresponding uncertainties. The proper estimation of hydraulic

heterogeneity as an initial step was found to be of paramount importance in designing, conducting, and analyzing partitioning tracer tests.

Hyperspectral Exploitation with Plant Sentinels

Shaw, A.K., J. Medford, M. Antunes, W.S. McCormick, and D. Wicker.

Chemical and Biological Sensing VIII.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6554, 2007

Plant sentinels can serve as inexpensive plant-based biological early-warning systems capable of detecting substances that are harmful to humans or the environment. The de-greening circuits in a laboratory plant, *Arabidopsis*, induce rapid chlorophyll loss and change color under the influence of synthetic estrogens. The bio de-greening phenomenon is detectable by human eyes or with a system (chlorophyll fluorescence) that currently works best in laboratory conditions. To make a viable plant sentinel system, the authors are developing an automated monitoring scheme for early detection of the de-greening phenomenon that will lead to practical application. This paper presents novel and effective HSI-based algorithms for early hyperspectral image detection of de-greening of plants and vegetation due to the presence of explosives or chemical agents. The detector will be capable of monitoring the plant sentinels 24/7 to detect even slight discoloration of the plant sensors, thus serving as an early-warning system. Preliminary results are presented for estimating the length of time that the explosive or chemical agent has been present.

Hyperspectral Imaging Based Techniques Applied to Polluted Clay Characterization

Bonifazi, Giuseppe and Silvia Serranti.

Optics for Natural Resources, Agriculture, and Foods.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6381, 2006

Building upon previous research conducted to evaluate the potentialities of the hyperspectral imaging approach in characterization of soil pollution, the goal of this project is to evaluate the results obtainable in an investigation of an "ad hoc" polluted benthonic clay--the type of material usually utilized to line a rubbish dump—in order to define fast and reliable control strategies for monitoring the status of the material.

Implementation of Vapor Intrusion Evaluation: What Might You Find?

Phillips, J. and L. Collins.

Land Contamination & Reclamation, Vol 14 No 2, p 599-604, 2006

This paper summarizes work at industrial sites (including manufactured gas plant (MGP) sites) where U.S. EPA guidance has been used to evaluate the potential indoor air risk from vapor intrusion and the predicted outcome. The authors compare and contrast inputs and outputs of several evaluations to illustrate the importance of collecting site-specific soil information (e.g., soil type, soil bulk density, total porosity, water-filled porosity) and building information (e.g., air exchange rate, flow rate into building, building dimensions). The authors' experience with MGP sites suggests that the vapor intrusion pathway seldom drives remedial action.

Initial Test Results of a Passive, Discrete Multi-Level Sampling Device for Vertically Defining Groundwater Contamination in Monitoring Wells

Herzog, David W.

Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007

This presentation introduces a new groundwater sampling device that allows for vertical profiling within a well screen. Initial field tests in wells known to be contaminated with petroleum hydrocarbons and MTBE show variation of contaminant concentrations within test wells, suggesting that the device may be reliable for vertically defining groundwater contamination.

In-Situ Measurements of Cu in an Estuarine Environment Using a Portable Spectrophotometric Analysis System.

Callahan, M.R., E.A. Kaltenbacher, & R.H. Byrne.

Environmental Science & Technology, Vol 38, p 587-593, 2004

The spectrophotometric elemental analysis system (SEAS) used for in situ observations of copper concentrations is capable of fully autonomous or user-controlled operations. The optical cells are flexible liquid core waveguides with optical path lengths as long as 5 m. The 1-m waveguide used in the present study provided a 3.0 nM detection limit and a 5.0% relative standard deviation for a 25 nM copper sample. Analysis times range between 1 and 5 min. The details of copper concentrations determined in field deployments of SEAS-Cu in Tampa Bay, FL, are disclosed.

In Situ Perchlorate Determination on Purolite A850 Ion Exchange Resin via Raman Spectroscopy

Levitskai, T.G., S.I. Sinkov, and S.A. Bryan, Pacific Northwest National Lab, Richland, WA. Vibrational Spectroscopy, Vol 44 No 2, p 316-323, 17 July 2007

Raman spectroscopy was demonstrated as a detection method for the determination of perchlorate loading on a non-selective ion exchange resin, Purolite A850 acrylic gel. This method has been established using laboratory water (DIW) samples and actual California groundwater (CAGW) samples that contain competing ions, dissolved organics, and other potential interfering agents. The detection limit for this method of monitoring perchlorate on resin was measured to be 0.014 miliequivalent/g for both DIW and CAGW systems.

Insight into Pollutant Bioavailability and Toxicity Using Raman Confocal Microscopy
Singer, A.C., W.E. Huang, J. Helm, and I.P. Thompson, Centre for Ecology and Hydrology-Oxford, UK.

Journal of Microbiological Methods, Vol 60 No 3, p 417-422, Mar 2005

Raman confocal microscopy was used to discriminate between cultures of Burkholderia xenovorans LB400 exposed to four different common environmental pollutants: phenanthrene, dodecane, 3-chlorobiphenyl, and pentachlorophenol. This paper presents evidence for the application of Raman spectroscopy as a bioassay for pollutant bioavailability and toxicity.

An Integrated NMR/Nanosensor System for Sensitive Detection of Environmental Toxins and Harmful Microbes

Perez, J.M., D.P. Fries, and J.J. Hickman University of Central Florida, US

Nanotech 2007: Technical Proceedings of the 2007 NSTI Nanotechnology Conference and Trade Show. NSTI: Nano Science & Technology Institute, ISBN: 1-4200-6183-6, Vol 2, p 663-665

Nanoparticles, when coupled to affinity ligands, have been utilized as chemical sensors to detect DNA and to create immunoassays for the detection of bacteria and toxins. However, these methods cannot be used in turbid media and they require non-portable instrumentation. An alternative technique is to use non-toxic iron oxide based magnetic nanoparticles. In this case, a superparamagnetic nanoparticle, which can be detected magnetically, is added to the media. This detection approach relies on the effect that iron oxide-based nanoparticles have on the NMR signal of neighboring water molecules, and it utilizes non-portable instrumentation. No separation is required for the technique and it has been performed in whole blood, lipid emulsion, and tissue culture media. Work is currently being done to expand the application to other toxins and pathogens in clinical and environmental samples.

Interim Report on the Evolution and Performance of the Eichrom Technologies Procept Rapid Dioxin Assay for Soil and Sediment Samples

U.S. EPA, Superfund Innovative Technology Evaluation Program.

EPA 540-R-07-001, 45 pp, Jan 2007

One of the participants in the earlier Superfund Innovative Technology Evaluation (SITE) dioxin demonstration was Hybrizyme Corporation, which demonstrated the use of the AhRC PCR(tm) Kit. This technology reported the concentration of aryl hydrocarbon receptor (AhR) binding compounds in a sample, with units reported as Ah Receptor Binding Units (AhRBU). At the time of the original demonstration, this particular technology was intended for use as a screening tool to rank samples from those inducing the greatest AhR activity to those inducing the least AhR activity rather than to provide highly quantitative dioxin concentration in units of toxicity equivalents (TEQ). After the SITE Dioxin demonstration, this technology was exclusively licensed to Eichrom Technologies. Eichrom focused their efforts on developing optimal sample preparation procedures for the assay and reporting TEQ values instead of AhRBU. The technology is now marketed under the trade name Procept(r) Rapid Dioxin Assay. This report describes the experimental design of the site-specific study, the analytical methods used, and comparisons of the toxicity equivalents (TEQ)D/F results from the high-resolution mass spectrometry (HRMS) data to those reported by Eichrom Technologies Procept(r) Rapid Dioxin Assay. The data generated and evaluated during the site-specific study showed that the TEQ data produced by the Procept(r) Rapid Dioxin Assay was more comparable to the HRMS TEQD/F data than was the data reported using the Hybrizyme AhRC PCR(tm) Kit in the original SITE demonstration. The Procept(r) Rapid Dioxin Assay could be used as an effective screening tool to determine areas of greatest concern for cleanup at a site and could help to minimize the number of more expensive analyses needed for specific analytes, particularly considering that the cost and the time to analyze samples is significantly less than that of HRMS analyses.

<http://www.epa.gov/nerlesd1/cmb/pdf/eichrom-web508.pdf>

Inverting Residual Self-Potential Data for Redox Potentials of Contaminant Plumes

Linde, N. (ETH-Zurich, Inst. of Geophysics HPP, Zurich, Switzerland); A. Revil (CNRS-CEREGE, Aix-en-Provence, France).

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract NS44A-04, 2007

Self-potential (SP) data can be separated into a streaming-potential component associated with pore water flow and a redox-potential component sensitive to differences in the redox potentials of organic-rich contaminant plume areas. The authors present the first inversion method that uses residual SP (corrected for the streaming potential component) to invert for the redox potentials of contaminant plumes. In a two-layered electrical conductivity structure where the boundary corresponds to the water table, the electrical dipole sources are assumed to be associated with microbial breakdown of contaminants at the water table. The inverse method was applied to residual SP estimated from SP measurements collected at the ground surface in the vicinity of a landfill. The estimated redox potentials correlated well with in situ measurements and the estimated amplitudes of the redox potentials were similar to those measured in situ. A sensitivity analysis indicates that meaningful estimates of the redox potential can be derived even if the electrical conductivity structure is only known within an order of magnitude. These results provide further evidence that the SP method can be useful to monitor the spreading of contaminants around landfills and to evaluate the efficiency of remediation programs.

Investigating Transient Heterogeneity in a Bioactive Hydrocarbon Plume Using GPR and PVPs

Devlin, J.F., P. Schillig, M. McGlashan, G. Tsoflias, and J. Roberts, Univ. of Kansas, Lawrence. Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract NS44A-03, 2007

Time-dependent perturbations in flow have been documented in chemically active systems (e.g., reactive barriers) and bioactive systems (e.g., contaminant plumes), but data are limited from investigations of transient heterogeneity in contaminant plumes in the field. In an investigation of the potential for perturbations to occur due to biomass growth, gas production, and chemical precipitate formation, a controlled gasoline release study was conducted at one end of a sheet-pile alleyway in which groundwater was flowing at a constant rate of about 10 cm/day. Several meters downgradient of the release, the aquifer was instrumented with oxygen-releasing compound wells, 5 groundwater point velocity probe (PVP) multilevel stands, and 6 ground-penetrating radar (GPR) access tubes installed to a depth of about 5 m surrounding a section of the aquifer measuring about 2 m (along the flow direction) by 4 m (across the flow direction). Changes in the aquifer character following oxygen addition was monitored by repeated PVP measurements of groundwater velocities at 20 points across the plume and by using GPR to obtain several tomographic images of the aquifer through time. The data suggest that the aquifer responded to the oxygen additions with changes to the flow system.

Kinetic Behavior of Polymer-Coated Long-Period-Grating Fiber-Optic Sensors.

Widera J., C.E. Bunker, G.E. Pacey, V.R. Katta, M.S. Brown, J.L. Elster, M.E. Jones, J.R. Gord, and S.W. Buckner

Appl Opt. 2005 Feb 20; 44(6):1011-7.

A kinetic analysis approach using the time-dependent response of long-period-grating (LPG) fiber-optic sensors is introduced. This method is different from previous studies in that it allows analysis of the time-dependent wavelength shift of the sensor rather than operating the LPG sensing element in an equilibrium mode and modeling with Langmuir adsorption behavior.

The detailed kinetic model presented is based on diffusion of the analyte through the outer protective membrane coating into the affinity coating, which is bound to the fiber cladding. The approach is demonstrated by employing a commercial Cu^{+2} sensor with a carboxymethylcellulose sensing element. The mathematical model employed fits the time-dependent behavior well and provides a means of calibrating the concentration-dependent time response which for copper are below ppm levels. The kinetic model is faster for measuring low concentrations of the analyte, than the equilibrium method where equilibration times are long. The kinetic model should be applicable to other affinity-coated LPG fiber-optic sensors.

A Laboratory Study of Sediment and Contaminant Release During Gas Ebullition

Yuan, Qingzhong, K.T. Valsaraj, G.A. Cain, and M. Cain, Louisiana State Univ., Baton Rouge); D.D. Reible (Univ. of Texas, Austin); C.S. Willson (Louisiana State Univ.).

Journal of the Air & Waste Management Association, Vol 57 No 9, Sep 2007

Contaminated sediments often contain labile organic matter that can generate significant quantities of gas. The behavior of gas in sediments and the resulting migration of a polyaromatic hydrocarbon (phenanthrene) were investigated in an experimental system with methane injection at the base of a sediment column. The study showed that partition and sediment suspension are two factors responsible for contaminant transport during bubble ebullition. In field conditions, both gas flux and sediment suspension rates are small, and effective mass transfer coefficients estimated from the experimental data indicate that contaminant release due to gas ebullition is not expected to be significant relative to contaminant release from bioturbation in uncapped sediment. Sand caps are effective in reducing gas bubble-associated contaminant release from sediment. With the help of X-ray computed tomography techniques, the investigators observed that bubble movement could redistribute the void spaces and increase pore water circulation in sediment, thus changing the sediment structure and integrity.

Laser Mass Spectrometry: Rapid Analysis of Polychlorinated Biphenyls in Exhaust Gas of Disposal Plants

Dobashi, S., Y. Yamaguchi, Y. Izawa, and Y. Deguchi (Mitsubishi Heavy Industries Ltd.); A. Wada (Kobe Univ.); M. Hara (Tokyo Inst. of Technology).

Journal of Environment and Engineering, Vol 2 No 1, p 25-34, 2007

Effective prevention of PCB leakage to the atmosphere requires rapid analysis with on-line detection, but conventional methods require extensive analytical time (several days per sample) and are thus unsuitable. Research was conducted to develop a laser ionization/ion trap storage/time of flight mass spectrometry (LI-IT-TOFMS) method capable of monitoring PCBs within 1 min/sample when applied to exhaust gas and the atmosphere of the disposal plant. The achievable PCB sensitivity for on-line measurement was found to be in the pptV range ($< 0.01 \mu\text{g}/\text{m}^3\text{N}$). A satisfactory proportional relationship was confirmed between laser-based and conventional gas sampling/GC-MS results for PCBs. The exhaust gas in a PCB treatment plant (hydrothermal decomposition and container treatment processes) was measured using the PCB monitoring system, which confirmed that PCB monitoring is possible without interference from either the main gas composition or minor coexisting substances. The LI-IT-TOFMS method presents a useful method for the trace analysis of PCBs in exhaust gas.

http://www.jstage.jst.go.jp/article/jee/2/1/2_25/_article

Laser Systems for Stand-Off Detection of Contamination and Pollution of Atmosphere
Mierczyk, Zygmunt.

Laser Technology VIII: Applications of Lasers.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6598, 2007

Laser systems can be used for remote detection of contamination and atmospheric pollution. Stand-off systems provide detection of pollution (gas, aerosol, smoke, dust) at long distances, without contact with the contaminated area. These systems are active laser systems (lidars) or passive thermal systems with narrow filters matched to the bands of gas absorption and imaging the transmission changes of radiation absorbed along the path by the gases presence. A single stand-off station can cover a significant area, the size of which depends on the range of sampling radiation, field of view, and scanning speed. Remote systems employ various types of small point sensors, and the data from these sensors are transmitted by wire or wireless connections to alarm centers. Remote detection is performed by the transmission systems of measurement data, and contact between the sensor and the analyzed area is necessary. This paper describes the construction, principles of operation, and basic analytical characteristics of standoff and remote measuring systems developed at the Military University of Technology for continuous monitoring of contaminants and atmospheric pollutants.

A Literature Review of Wipe Sampling Methods for Chemical Warfare Agents and Toxic Industrial Chemicals

U.S. EPA, National Exposure Research Laboratory, Las Vegas, NV.

EPA 600-R-07-004, 59 pp, Jan 2007

Wipe sampling is an important technique for the estimation of contaminant deposition in buildings, homes, or outdoor surfaces as a source of possible human exposure. Numerous methods of wipe sampling exist, and each method has its own specification for the type of wipe, wetting solvent, and determinative step to be used, depending upon the contaminant of concern. The objective of this report is to concisely summarize the findings of a literature review that was conducted to identify the state-of-the-art wipe sampling techniques for a target list of compounds. This report describes the methods used to perform the literature review; a brief review of wipe sampling techniques in general; an analysis of physical and chemical properties of each target analyte; an analysis of wipe sampling techniques for the target analyte list; and a summary of the wipe sampling techniques for the target analyte list, including existing data gaps. In general, no overwhelming consensus can be drawn from the current literature on how to collect a wipe sample for the chemical warfare agents, organophosphate pesticides, and other toxic industrial chemicals of interest to this study. Different methods, media, and wetting solvents have been recommended and used by various groups and different studies. For many of the compounds of interest, no specific wipe sampling methodology has been established for their collection. Before a wipe sampling method (or methods) can be established for the compounds discussed in this report, two steps must be taken: (1) conduct investigative research to fill in the gaps in wipe sampling knowledge, and (2) conduct method validation to optimize the methods.

<http://www.epa.gov/nhsr/pubs/reportWipe042407.pdf>

Mass Spectrometry for Monitoring Micropollutants in Water
Rosen, Ran, Agentek Ltd., Tel Aviv, Israel.

Current Opinion in Biotechnology, Vol 18 No 3, p 246-251, June 2007

Traditional methods for monitoring water quality have been based on gas chromatography/mass spectrometry or liquid chromatography with UV/fluorescence detection. These methods require multistep sample preparation, and several have low specificity. Liquid chromatography tandem mass spectrometry now has become a key technique for environmental analysis, allowing the detection of a wide range of polar and nonvolatile compounds. The use of this method has increased the specificity and confidence of identification, while reducing sample preparation to a minimum.

Measurement of Atmospheric Fluxes of Radionuclides at a UK Site Using Both Direct (Rain) and Indirect (Soils) Methods

Short, D.B. (Robert Morris Univ., Moon Township, PA); P.G. Appleby (Univ. of Liverpool, UK); J. Hilton (Centre for Ecology and Hydrology, Winfrith, Dorset, UK).

International Journal of Environment and Pollution, Vol 29 No 4, p 392-404, 2007

An analytical methodology was designed for the measurement of Pb-210 and Be-7 in rainwater. Atmospheric inputs of radionuclides to the test area were recorded, and rainwater fluxes then were compared with measurements from soil cores. The annual deposition from April 1997 to March 1998 of Pb-210 and Be-7 was $165 \pm 8 \text{ Bq/m}^2$ and $3912 \pm 120 \text{ Bq/m}^2$, respectively, compared to an indirect Pb-210 flux of $148 \pm 7 \text{ Bq/m}^2/\text{yr}$ calculated from soil core records.

Measurement of Contaminant Discharge into the Columbia River Along the Hanford Reach Using a Passive Flux Chamber

Mendoza1, Donny, Brad Fritz, and Greg Patton, Pacific Northwest National Laboratory, Richland, WA

Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007. Poster presentation, p 124, 2007

Past operations at Hanford Site have resulted in the release of contaminants, primarily uranium, which have migrated to the groundwater and ultimately discharge to the Columbia River. To better determine what the uranium flux to the river is a passive flux chamber was installed in the hyporheic zone. The flux chamber consisted of a 91.4 cm diameter galvanized dome with a bidirectional flow meter. Groundwater flow data measured in the flux chamber was consistent with calculated estimates using hydraulic gradient measurements. Future work will deploy passive water samplers coupled with the flux chamber to provide an estimate of uranium flux into the Columbia River.

Measurement of Total Site Mercury Emissions for a Chlor-Alkali Plant Using Open-Path UV-DOAS

U.S. EPA, National Risk Management Research Laboratory, Research Triangle Park, NC.
EPA 600-R-07-077, 146 pp, July 2007

In December 2003, U.S. EPA promulgated the National Emission Standard for Hazardous Air Pollutants for mercury cell chlor-alkali plants. In February 2004, the Natural

Resources Defense Council filed petitions on the final rule in U.S. district court citing, among other issues, the inability of mercury cell industries to fully account for mercury added to their processes to make up for losses via wastes, products, and emissions. In April 2004, EPA agreed to reconsider aspects of the rule making, which led to planning and execution of emission measurement projects designed to reduce uncertainty in fugitive emissions of Hg from mercury cell chlor-alkali plants. As an overall project goal, the research will use the total site mercury emission data presented in this report, in conjunction with cell room vent monitoring, stack emission and maintenance activity data to determine if the elemental mercury cell room fugitive emissions from the observed facilities are on the order of historical assumptions (1,300 g/day) or on the order of 2002 levels of unaccounted-for mercury (approximately 10,000 g/day).
<http://www.epa.gov/nrmrl/pubs/600r07077/600r07077.htm>

Measuring the Flux at the Interface of Coal-Tar Impacted Sediment and River Water Near a Former MGP Site

Hyun, S., C.T. Jafvert, B. Jenkinson, C. Enfield, and B. Johnson, Purdue Univ., West Lafayette, IN.

Chemosphere, Vol 68 No 6, p 1020-1029, June 2007

This paper discusses field studies that were performed to characterize the water flow across the sediment-water interface within a river adjacent to a former manufactured gas plant. The studies used a new design of interfacial flow meter. The instrument consists of a cylinder with an interfacial area of 2,342 cm²; a dome attached to the cylinder; and a flow tube that allows water to flow from inside the dome to the river. A 'heat-pulse' method is used to measure the flow rate across the sediment water interface. To estimate contaminant flux the flow data are combined with separately obtained contaminant (polycyclic aromatic hydrocarbons) pore water data from the same area. Information on mass flux at the sediment-water interface is useful for risk assessment and the evaluation of remedial alternatives.

Microalgal Fiber-Optic Biosensors for Water Quality Monitoring

Orellana, G., L. Villen, D. Haigh, E. Maneiro, F. Marva, and E. Costas.

Third European Workshop on Optical Fibre Sensors.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6619, 2007

Novel fiber-optic biosensors have been developed for the analysis of pesticides in water based on Chlorophyceae microalgae immobilized into a porous silicone layer as recognition element, and on measurements of the photogenerated O₂ as chemical transducer. The inhibition of O₂ production by the photosynthetic green algae in the presence of a pesticide (simazine) was used as the biological signal. Luminescent thin films and a dedicated optoelectronic unit based on emission phase-shift measurements support the sensitive O₂ measurements. Fluctuation analysis allows selection of sensitive and resistant microalgae mutants without genetic manipulation for maximum biosensing selectivity.

Microbiological Monitoring of a Wetland Treating AMD by T-RFLP and Clone Libraries
Riefler, Guy, John Krinks, Ben Stuart, and Peter Coschigano, Ohio University.

The 29th Annual Conference: National Association of Abandoned Mine Land Programs (NAAML), 7-10 October 2007, Bloomington, Indiana: Program and Abstracts.

Acid mine drainage (AMD) contaminated with high levels of manganese is often difficult to treat because pH needs to be raised above 9 for effective abiotic precipitation. A biological treatment process has been developed that directs AMD through a limestone bed inoculated with a lab-cultured mixture of manganese oxidizing bacteria. In a treatment system in Northeast Ohio, microbiological samples of biofilm scraped from the surface of limestone gravel three years after inoculation were collected from inoculated and non-inoculation locations. Terminal restriction fragment length polymorphism (t-RFLP) analysis and clone libraries combined with gene sequencing were used to determine if the inoculated population was significantly different than the wild population. The results showed a significant difference between the inoculated and non-inoculated areas of the system. Sequencing results indicated that a variety of species were detected in the inoculated area that for the most part could be described as metal oxidizing bacteria. The t-RFLP profiles of the microbial communities at two inoculated locations indicated strong similarities. In comparison, only a small fraction of the microbial population from the non-inoculated area consisted of metal oxidizers.

Miniature FT-IR Spectrometer for Passive and Active Sensing

Manning, C., M. Gross, J. Jennings, J. Wuthrich, and A. Samuels.

Chemical and Biological Sensors for Industrial and Environmental Monitoring II.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6378, 2006

The development of a novel handheld Fourier-transform infrared spectrometer (FTIS) system is described. The estimated and measured performance data presented are based on modeling and preliminary testing. The basic instrument will be useful for a variety of sensing applications, including chemical agent detection. One novel aspect is a refractively-scanned, field-widened interferometer, providing energy equal to a laboratory spectrometer in a miniature footprint. A second novel aspect is the use of solid-phase extraction to concentrate airborne chemicals for infrared detection. FTIS instruments provide a powerful approach to identification of chemical and biological substances. The specificity is very high, while the sensitivity varies with sampling interfaces and detection methods. Photoacoustic detection provides a low-cost and relatively sensitive sampling interface. Modeling indicates that the sensitivity can reach ppb to ppt levels.

Modeling Multiple Scattering and Absorption for a Differential Absorption LIDAR System

Blevins, Daniel D., Ph.D. dissertation, Rochester Inst. of Technology, NY, 331 pp, 2005

The Digital Image and Remote Sensing Image Generation (DIRSIG) model has been developed and utilized to support research at the Rochester Institute of Technology (RIT) for over a decade. The model is an established, first-principles-based scene simulation tool that has been focused on passive multi- and hyperspectral sensing from the visible to long wave infrared (0.4 to 14 micrometers). Leveraging photon mapping techniques utilized by the computer graphics community, a first-principles-based elastic light detection and ranging (LIDAR) model was incorporated into the passive radiometry framework so that the model calculates arbitrary, time-gated photon counts at the sensor for atmospheric, topographic, and backscattered returns.

The active LIDAR module handles a wide variety of complicated scene geometries, a diverse set of surface and participating media optical characteristics, multiple bounce and multiple scattering effects, and a flexible suite of sensor models. This robust modeling environment allows the researcher to evaluate sensor design trades for topographic systems and the impact that scattering constituents (e.g., water vapor, dust, sediment, soot) may have on a differential absorption LIDAR (DIAL) system's ability to detect and quantify constituents of interest within volumes including water and atmospheric plumes. The interest in modeling DIAL sensor engagements involving participating media such as gaseous plumes presented significant challenges that were overcome using the photon mapping paradigm. Researchers suspect that multiple scattering effects from additional constituents as simple as water vapor or soot could affect a DIAL sensor's ability to detect and quantify effluents of interest within a participating medium. Traditional techniques, however, are not conducive to modeling the multiple scattering and absorption within a non-homogenous finite volume, such as a plume.

<http://dirtsig.cis.rit.edu/doc/blevins.pdf>

Modified Micro Suction Cup/Rhizobox Approach for the In-Situ Detection of Organic Acids in Rhizosphere Soil Solution

Dessureault-Romppe, J., B. Nowack, and R. Schulin (Inst. of Terrestrial Ecology, ETH Zurich, Switzerland); J. Luster (Swiss Federal Inst. for Forest, Snow, and Landscape Research). Plant and Soil, Vol 286 Nos 1-2, p 99-107, 2006

In phytoremediation studies, root/soil interactions can strongly influence the soil solution chemistry in the rhizosphere. A modification of the classical rhizobox/micro suction cup system was proposed to make it suitable for the collection and analysis of organic acids in the rhizosphere. The modified system was tested with *Lupinus albus* L. as a model plant known to exude large amounts of citrate. Suction cups were installed through the transparent front plate of the rhizoboxes just after the emergence of cluster roots to allow optimal localized collection of soil solution. To prevent microbial degradation, a small dead volume allowed almost immediate stabilization with formaldehyde of the sampled soil solutions in the collection container. The concentrations of organic acids were significantly larger in the rhizosphere soil solution of active cluster roots of *Lupinus albus* L. than in the bulk soil solution. The authors were able to follow the exudation process in situ over a 2- to 3-day period. The concentrations of other organic acids and inorganic anions differed between the bulk soil and the rhizosphere of cluster roots, normal roots, and nodules.

<http://www.ito.ethz.ch/people/nowack/pdf/Dessureault%20%282006%29.pdf>

Monitoring Poisons in the Environment: A Woolly Matter ScienceDaily, 6 Apr 2007

Heavy metals are present in variable amounts in the natural environment in the UK. At the Society for Experimental Biology's Annual Meeting in Glasgow (31 March - 2 April), Dr. Jennifer Sneddon of Liverpool John Moores University presented the results of a pilot study assessing the use of upland sheep wool as a bio-monitoring device for natural levels of heavy metals. In the experiment, a handful of wool was taken from the shoulder area of rare and heritage breeds of sheep grazing on hills in the Lake District and North Wales. The wool was washed to ensure that only metabolized deposits of heavy metals were detected, rather than anything that had stuck to the outside of the wool. Copper and lead concentrations were then

determined using highly sensitive equipment, and these results were compared with concentration data from local streams. Significant correlations were found between the amount of copper and lead found in washed wool from sheep and in streams. Shetland sheep appeared to accumulate more lead than Swaledale sheep. Another significant observation related to the sex of the sheep: values for wool concentration of both lead and copper were significantly higher in male sheep, which has been linked to the effect of androgens on metabolism. Heavy metal concentrations previously have not been assessed in this way. Future studies are planned to assess how the age of the sheep and different areas of wool growth on the animal influence results. Potentially, sheep can be of future use in bioremediation studies on brownfield sites.

Monitoring Subsurface Contamination Using Tree Branches

Gopalakrishnan, Gayathri, M. Cristina Negri, Barbara S. Minsker, and Charles J. Werth.
Ground Water Monitoring & Remediation,
Volume 27 Issue 1 Page 65-74, Winter 2007

This paper proposes a method of assessing the distribution of chlorinated solvents in soil and ground water using tree branches. They are part of a phytoremediation effort at Argonne National Laboratory. The phytoremediation system is divided into two parts: willows that are planted in contaminated soil and poplars that are planted in contaminated groundwater. Branch samples were collected from 126 willows and 120 poplars with samples from 31 soil borings and six monitoring wells. Regression analysis of the results indicated correlation coefficients of at least 0.89. Kriging of the TCE soil concentrations and willow branch data showed good agreement. Further research is necessary prior to using this method as a quantitative monitoring tool for soil and groundwater.

A Multilevel System for High-Resolution Monitoring in Rotasonic Boreholes

Parker, Beth L., John A. Cherry, and Benjamin J. Swanson
Ground Water Monitoring & Remediation,
Volume 26 Issue 4 Page 57-73, Fall 2006

Detailed vertical monitoring was obtained from nine rotasonic holes in overburden and bedrock between 20- and 30-m (65- and 100-feet) deep at two sites. The system, which accommodates up to 15 monitoring ports provided information on hydraulic head and contaminant distributions that would have been missed with fewer monitoring intervals. The modular multilevel system can be set up in any borehole produced with a dual-casing drilling method. Because it uses a peristaltic pump, it is most effective where static water levels are shallower than 9 m (30 feet) below ground surface. The monitoring intervals are separated by bentonite seals. All system components (flush joint polyvinyl chloride (PVC) casing segments, stainless steel ports, Teflon® tubing, and PVC centralizers) are commercially available. An open 6-mm (¼-inch) inner diameter tube is connected to each port for manual hydraulic head measurements and water sampling with a peristaltic pump.

Multiwalled Carbon Nanotubes for Speciation of Chromium in Environmental Samples
Tuzen, Mustafa and Mustafa Soylak

Journal of Hazardous Materials, Volume 147, Issues 1-2, p 219-225, 17 August 2007

This paper discusses the use of ammonium pyrrolidine dithiocarbamate (APDC) to chelate Cr(VI) out of a water sample. The water sample with the APDC-Cr(VI) is then poured through a carbon nanotube bed where the APDC-Cr(VI) is sorbed on the nanotube walls. The absorbed chelate is extracted from the nanotube using a nitric acid/acetone solution. This solution is evaporated and the concentrated residue is analyzed using flame atomic absorption. The detection limit based on the 3σ criterion was 0.90 g/L for Cr(VI).

<http://www.aseanenvironment.info/Abstract/41015556.pdf>

New Characterization Tools Used In and Around Hanford's Single-Shell Tank Farms
Myers, D.A. and H.A. Sydnor, CH2M Hill Hanford Group, Inc., Richland WA.

Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007

This paper reports on the development of two new techniques to enhance the completeness of investigations, speed the collection of data, and reduce the overall cost of characterization. The surface geophysical exploration (SGE) consists of a suite of geophysical tools that may be applied (high resolution resistivity (HRR), ground penetrating radar, electromagnetic induction, and magnetic gradiometry) to a site. SGE is supplemented with focused sampling using a direct push drill system (DPT). These two systems were used in tandem, and in an iterative manner to more completely characterize the entire subsurface of the tank farm Waste Management Areas. In the farm area HRR electrodes have been permanently placed in the ground to allow for subsequent interrogation. The DPT uses drive shoes with a disposable tip to place deep electrodes for SGE investigation. The maximum depth achieved to date has been 110 ft. The system also can push at angles of 30° , 45° , and 60° from the vertical allowing investigation beneath existing structures.

New Concept Design of Differential Absorption Lidar: Fusion of DIAL and TDLS Methods
Lytkine, A., B. Lau, A. Lim, W. Jaeger, and J. Tulip.

Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing III.
Proceedings of SPIE—The International Society for Optical Engineering, Volume 6750, 2007

The authors propose a new approach to range-resolved remote gas sensing in the atmosphere based on a combination of a DIAL and tunable-laser diode spectroscopy (TDLS) methods. Adding range-resolving capabilities to a TDLS sensor involves arranging a group of retroreflectors (RRs) dividing an absorption path into adjacent measurement sections similar to those utilized by conventional DIAL systems. Two techniques were implemented for the interrogation of the RRs: scanning a beam of a continuous-wave laser over RRs sequentially and using a time delay between returns from different RRs illuminated with a pulsed laser. The scanning technique employed a vertical-cavity surface-emitting laser (VCSEL) operating near 1389 nm. A single-pulse interrogation method was demonstrated with a quantum cascade laser suitable for detection of ammonia, ethylene, and water vapor in the atmosphere. Gas sensing and ranging was performed over distances varying from ~1 m up to ~1 km. With VCSEL, the device attained a 0.5-s time resolution in gas concentration profiling with a 10-cm spatial resolution. Minimum interrogation time of a group of RRs was ~9 ms. A new generation of differential absorption LIDARs can be developed for range-resolved gas sensing in the atmosphere over

distances up to 1 km for applications ranging from fence-line monitoring of industrial areas to continuous air quality control in populated areas.

A New Depth-Discrete Multilevel Monitoring Approach for Fractured Rock

Cherry, John A., Beth L. Parker, and Carl Keller.

Ground Water Monitoring & Remediation, Vol 27 No 2, p 57-70, Spring 2007

The FLUTE and Water FLUTE, a depth-discrete multilevel monitoring system were used to sample a trichloroethylene and metolachlor contaminated fractured dolostone aquifer. The FLUTE is a continuous packer for temporarily sealing boreholes. The Water FLUTE can be used for temporary or permanent groundwater monitoring. Five boreholes ranging in diameter between 9.6 and 14.5 cm were sampled to depths of 150 m. The systems were custom designed for each borehole and included between 12 and 15 monitoring intervals.

A New Leak Detection System for Long-Distance Pipelines Utilizing Soil-Gas Techniques

Liang, K.F. and M.C. Tom Kuo.

Ground Water Monitoring & Remediation,

Volume 26 Issue 3 p 53-59, Summer 2006

This paper demonstrates the application of a leak detection system for long-distance gas pipelines. The system consists of intermittent porous tubes connected in series with impermeable polyethylene tubes that run underground and parallel to the pipeline. Field leak tests indicated that the effective detection distance of the new system was at least 30 m, while the effective detection radius from the conventional soil-gas probes is only ~5 m.

A New Paradigm in DNAPL Source Zone Characterization: 3D Imaging of Contaminant Distributions Through Hydraulic and Tracer Tomography

Illman, W.A., A.J. Craig, X. Liu, and A. Massi (Univ. of Iowa, Iowa City); T.J. Yeh (Univ. of Arizona, Tucson); D. Yin (Univ. of Iowa); J. Zhu (ARCADIS U.S., Inc., Tucson, AZ).

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract B43B-04, 2007

This presentation describes an alternative to traditional approaches for characterization of DNAPL source zones. Implementation of hydraulic and tracer tomography requires far fewer boreholes than the traditional coring techniques used to image a DNAPL source zone. The proposed approach first analyzes the information derived from hydraulic tomography, a new type of aquifer test, to identify the 3D hydraulic heterogeneity of the aquifer. The newly derived knowledge of heterogeneity is then used to design partitioning tracer tomography tests to depict the spatial distribution of DNAPL saturation in the source zone. The proposed techniques have been tested numerically and are being validated in laboratory sandbox experiments.

The Next Generation of TDLAS Analyzers

Frish, M.B.; M.C. Laderer; R.T. Wainner; A.O. Wright; A.H. Patel; J. Stafford-Evans; J.R. Morency; M.G. Allen; B.D. Green.

Next-Generation Spectroscopic Technologies.

Proceedings of SPIE -- The International Society for Optical Engineering, Volume 6765, 2007

The recent advent of lightweight battery-powered standoff tunable diode laser absorption spectroscopy (TDLAS) sensors is enabling novel applications for remote gas sensing and non-contact process monitoring. This paper provides an overview of these TDLAS tools.

Nonlinear Signal Contamination Effects for Gaseous Plume Detection in Hyperspectral Imagery
Theiler, J., B.R. Foy, and A.M. Fraser.

Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XII.
Proceedings of SPIE—The International Society for Optical Engineering, Volume 6233, 2006

When a matched filter is used for detecting a weak target in a cluttered background (such as a gaseous plume in a hyperspectral image), it is important that the background clutter be well-characterized. A statistical characterization can be obtained from the off-plume pixels of a hyperspectral image, but if on-plume pixels are inadvertently included, then that background characterization will be contaminated. In a broad area search scenario, where detection is the central aim, it is by definition unknown which pixels in the scene are off-plume, so some contamination is inevitable. In general, the contaminated background degrades the ability of the matched-filter to detect that signal. This could be a practical problem in plume detection. A linear analysis suggests that the effect is limited and vanishes in some cases. By taking the Beer's Law nonlinearity of plume absorption into account, the authors investigate the effect of that nonlinearity on signal contamination.

A Novel Detecting System with Full Fluorescent Spectra for Pesticides

Wang, Z.-D., Y.-J. Zheng, G.-C. Ruan, and Y.-T. Wang

Third International Symposium on Precision Mechanical Measurements.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6280, 2006

A detection system has been developed by applying the technologies of fiber-optic sensing, grating dispersion, and multi-channel image sensing (a charge-coupled device) based on the fluorescence mechanism of carbaryl. A pulsed xenon lamp is used as an excitation light source, optical fibers are selected to transmit and detect fluorescence, fluorescence dispersion is implemented with a small flat-field-grating spectrometer, and data gathering and A/D conversion are conducted with a high-speed signal-processing module. The system measures the fluorescence characteristics of carbaryl, obtaining a full-fluorescence spectrum of carbaryl in a single exposure under a UV excitation wavelength of 319 nm. The system has a good linear relationship in the range of 4.0~100.0 ng/mL of carbaryl liquor, and the minimum detection limit is 4.0 ng/mL at a linear correlation coefficient r of 0.9986. When this instrument is applied to the measurement of carbaryl in river water and ground water, recovery may approach 100%.

Occupational and Indoor Air Exposure to Persistent Organic Pollutants: A Review of Passive Sampling Techniques and Needs

Bohlin, P., K.C. Jones, and B. Strandberg, Goteborg Univ., Sweden.

Journal of Environmental Monitoring, Vol 9 No 6, p 501-509, June 2007

To date, passive (diffusive) air sampling (PAS) devices for persistent organic pollutants (POPs) have mainly been used as long-term samplers for outdoor air. There are several reasons, however, to develop PAS for POPs monitoring in occupational and indoor environments. This paper describes the potential advantages, limitations, and developments needed for PAS to be used reliably and routinely for POPs indoors and in occupational settings.

On-Site Polymer-Coated Hollow Fiber Membrane Microextraction and Gas Chromatography--Mass Spectrometry of Polychlorinated Biphenyls and Polybrominated Diphenyl Ethers

Basheer, C., M. Vetrichelvan, S. Valiyaveetil, and H.K. Lee.

Journal of Chromatography A, Vol 1139 No 2, p 157-1564, 19 Jan 2007

Porous polypropylene hollow-fiber membrane coated with a conjugated polymer was used as an on-site sampling device for the extraction of polychlorinated biphenyls and polybrominated biphenyl ethers from coastal sea water samples. Two fibers were used for each extraction. The coated hollow-fiber membranes were placed in a vial containing the sample, and the target compounds were extracted on site via manual shaking of the vials. After extraction, the fibers were carefully removed and placed in air-tight crimper vials, refrigerated, and then brought back to the laboratory for further processing. The analytes were desorbed by solvent in the laboratory, and analyses were carried out using gas chromatography/mass spectrometry. This method was highly reproducible, with relative standard deviations in the range of 1 to 9%. Recoveries from spiked water samples ranged from 83 to 98%. Low limits of detections between 0.04 and 0.21 ng/L were achieved. The extraction efficiency of this method was compared with the results of solid-phase microextraction.

Optical Sensors in Water Monitoring

Gaiglitz, Guenter.

Biophotonics 2007: Optics in Life Science. Proceedings of SPIE -- The International Society for Optical Engineering, Volume 6633, 2007

The European Community requires the protection of water resources and control of water quality. Coastal areas, rivers, ground water, wetlands, and especially drinking water require permanent monitoring to avoid pollution by small organic molecules, especially endocrine-disrupting compounds. Biosensors have demonstrated the proof of principle of immunochemistry for these applications. Optical methods based on fluorescence detection can be successfully used for the development of fast, sensitive, cost-effective, and easy-to-use analytical systems meeting the requirements given by EC Directives and national legislation. Results obtained with RIANA (RIver ANALyser) and AWACSS (automated water analyser computer supported system) are discussed.

Optimization of Operating Conditions for the Determination of Perchlorate in Biological Samples Using Preconcentration/Preelution Ion Chromatography

Canas, J.E., Q. Cheng, K. Tian, and T.A. Anderson, Texas Tech Univ., Lubbock

Journal of Chromatography A, Vol 1103 No 1, p 102-109, 20 Jan 2006

Few analytical methods have been developed for perchlorate determination in biological samples; however, a recently developed preconcentration/preelution (PC/PE) ion chromatography method has demonstrated the capability to analyze certain complex samples such as high-salinity water, milk, and hydroponic fertilizers. This paper details an investigation of the ability of this method to reduce sample background and lower detection limits in ion chromatography for various biological samples, such as kidneys, livers, zebrafish, quail eggs, lettuce, and urine. The investigation showed that the PC/PE method was capable of reducing sample background when compared to EPA Method 314.0, which resulted (except for zebrafish and urine) in detection limits that were two-fold lower than those achieved with Method 314.0.

Optimization of the Anthropogenic Vadose Zone Monitoring at the Sulfidic Mining Waste Dumps and Engineering Constructions

Twardowska, Irena and Sebastian Stefaniak.

Advanced Environmental, Chemical, and Biological Sensing Technologies IV.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6377, 2006

To attenuate the environmental impact of extractive wastes, the European Commission issued a directive on the management of waste from the extractive industries (2006) and a reference document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities (BREF, 2004). These documents oblige the extractive industry to intercept the generation of acid rock drainage (ARD). Because solid mining waste is widely used in civil engineering as a common fill, the potential of reused or disposed of mining waste to generate ARD and/or highly mineralized leachate must be monitored. Performance-based off-site techniques comprise sampling waste material along the waste layer profile by drilling, with subsequent pore solution extraction and analysis by ICP-MS. Though detailed and precise, these techniques are time-consuming and expensive, and thus are limited to randomly selected profiles. Large sites and heterogeneity of material causes problems with proper selection of representative profiles and therefore with evaluation of the environmental behavior of a reused or disposed material. For better characterization of a problematic site, a cone penetrometer integrated with real-time, downhole sensing devices equipped with sensors for measurements of temperature, pH, rock moisture content, and conductivity seems to be the best solution, providing important information concerning reactivity of material in the waste layer and the efficiency of protective measures.

Oxyanion Flux Characterization Using Passive Flux Meters: Development and Field Testing of Surfactant-Modified Granular Activated Carbon

Lee, J., P.S.C. Rao, I.C. Poyer, and R.M. Toole (Purdue Univ., West Lafayette, IN); M.D. Annable and K. Hatfield (Univ. of Florida, Gainesville).

Journal of Contaminant Hydrology, Vol 92 Nos 3-4, p 208-229, 17 July 2007

The use of surfactant-modified, silver-impregnated granular activated carbon (SM-SI-GAC) as a passive flux meter (PFM) sorbent was evaluated in the field in a shallow unconfined aquifer contaminated with perchlorate. PFMs packed with SM-SI-GAC were deployed in three existing monitoring wells with a perchlorate concentration range of ~2.5 to 190 mg/L. PFM-measured, depth-averaged groundwater fluxes ranged from 1.8 to 7.6 cm/day, while depth-averaged perchlorate fluxes varied from 0.22 to 1.7 g/m²/day. Groundwater and perchlorate flux distributions measured in two PFM deployments closely matched each other. Depth-averaged Darcy fluxes measured with PFMs were in line with an estimate from a borehole dilution test, but much smaller than those based on hydraulic conductivity and head gradients, possibly due to flow divergence caused by well-screen clogging. Flux-averaged perchlorate concentrations measured with PFM deployments matched concentrations in groundwater samples taken from one well, but not in two other wells, pointing to the need for additional field testing. The authors also discuss use of the surfactant-modified GACs for measuring fluxes of other anions of environmental interest.

Passive Air Sampler as a Tool for Long-Term Air Pollution Monitoring: Part 1. Performance Assessment for Seasonal and Spatial Variations.

Klánová, J., J. Kohoutek, L. Hamplová, P. Urbanová, and I. Holoubek

RECETOX - Research Centre for Environmental Chemistry and Ecotoxicology, Masaryk University, Kamenice 3/126, 625 00 Brno, Czech Republic.

Environ Pollut. 2006 Nov;144(2): p 393-405

The paper reports on the use of passive air sampling devices (polyurethane foam disks) to capture contaminants found in the air from local sources. The DEZA Valasske Mezirici, a coal tar and mixed tar oils processing plant, and the Spolana Neratovice, a chemical factory with the history of high production of organochlorinated pesticides (OCPs), were the targeted point sources of PAHs, and OCPs, respectively. The study indicated the passive samplers had a good capacity to reflect the temporal and spatial fluctuations of persistent organic pollutant (POP) concentrations in the ambient air and to provide information on the transport and fate of POPs in the vicinity of local sources of contamination.

Polarimetric Classification in a Tailings Deposition Area at the Timika Mine Site, Indonesia

Trisasongko, B., Brian Lees, and David Paull

Mine Water and the Environment, Vol 25 No 4, p 246-250, Dec 2006

This paper describes the results of using polarimetric synthetic aperture radar (SAR) to aid in characterizing remote tailings sites. The authors used Wishart polarimetric radar classification to map the tailings conditions and vegetative stress. A quality control check found that almost all scatters could be properly discriminated and that the technique could be used to distinguish saturated versus relatively dry tailings. This experiment demonstrated that there is potential value in using radar remote sensing to aid revegetation and monitor tailings stability.

Prediction of Down-Gradient Impacts of DNAPL Source Depletion Using Tracer Techniques: Laboratory and Modeling Validation

Jawitz, J.W., N. Basu, and X. Chen, Univ. of Florida, Gainesville.

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract H22C-03, 2007

Nonreactive tracers are commonly used to provide information about travel time distributions in hydrologic systems. Reactive tracers have been introduced as a tool to quantify the amount of NAPL contaminant present within the tracer swept volume. Researchers at the University of Florida have extended reactive tracer techniques to characterize NAPL spatial distribution heterogeneity. By conceptualizing the flow field through an aquifer as a collection of streamtubes, the aquifer hydrodynamic heterogeneities can be characterized by a nonreactive tracer travel time distribution, and NAPL spatial distribution heterogeneity can be similarly described using reactive travel time distributions. The combined statistics of these distributions are used to derive a simple analytical solution for contaminant dissolution. Applications are presented from numerical simulations using the multiphase flow and transport simulator UTCHEM and laboratory experiments of surfactant-enhanced NAPL remediation in 2D flow chambers.

Preparation and Characterization of a Soil Reference Material from a Mercury Contaminated Site for Comparability Studies

Kocman, David, Nicolas S. Bloom, Hirokatso Akagi, Kevin Telmer, Lars Hylander, Vesna Fajon, Vesna Jereb, Radojko Jaćimović, Borut Smodiš, Justinian R. Ikingura, and Milena Horvat
Journal of Environmental Management Volume 81, Issue 2, October 2006, Pages 146-154

This article discusses the preparation and validation of a mercury soil reference material (SOIL-1). The validation included homogeneity tests and intercomparison exercises for total (T-Hg) and methylmercury (MeHg). Descriptive statistics and analysis of variance (ANOVA) were used to look at the distribution of data from different analytical methods. Since cinnabar particles contain more than 90 % of total mercury, development of a homogenous sample was difficult to obtain. In order to achieve comparable results for the total mercury, it was necessary to use an HF acid digestion. The authors conclude that the results obtained for the SOIL-1 sample were of sufficient quality to suggest it can be used for quality control in laboratories analyzing mercury contaminated soils.

<http://www.aseanenvironment.info/Abstract/41013653.pdf>

Protocols for Collection of Surface Soil Samples at Military Training and Testing Ranges for the Characterization of Energetic Munitions Constituents

Hewitt, A.D., T.F. Jenkins, M.E. Walsh, M.R. Walsh, S.R. Bigl, and C.A. Ramsey.
ERDC/CRREL TR-07-10, 55 pp, July 2007

Energetic residues are distributed heterogeneously over military training ranges as particles of various sizes, shapes, and compositions. Most energetic residues are deposited on the surface, and the highest concentrations exist at firing positions, near targets, and where demolition activities are performed. In the case of impact and demolition ranges, the greatest quantities of residues are from rounds that fail to detonate as designed. To address the compositional and distributional heterogeneity associated with the distribution of particles and to obtain representative mean energetic residue soil concentrations, the sampling strategy must strive for the acquisition of samples that contain the constituents of concern in the same proportion to the bulk matrix as exists within the decision unit (sampled area, population, or exposure unit). This report summarizes the sampling strategies and designs that have been implemented for various types of military ranges, including hand grenade, antitank rocket, artillery, bombing, and demolition ranges. These protocols were developed during investigations on active ranges and primarily addressed potential surface source zones from which energetic residues could be migrating into surface and groundwater systems. A multi-increment sampling strategy was selected to accomplish this task after exposing the inadequacies of discrete sampling.

<http://www.crrel.usace.army.mil/library/technicalreports/ERDC-CRREL-TR-07-10.pdf>

Push-Pull Tests for Evaluating the Aerobic Cometabolism of Chlorinated Aliphatic Hydrocarbons: ESTCP Cost and Performance Report

Semprini, L., Oregon State Univ., Corvallis.

Environmental Security Technology Certification Program (ESTCP), ESTCP Project CU-9921, 46 pp, Sep 2006

Aerobic cometabolism is a promising technology for in situ remediation of chlorinated aliphatic hydrocarbons (CAHs). Low-cost methods are needed for generating the data required to

design field-scale systems. This report describes a newly developed single-well technology for evaluating the feasibility of using in situ aerobic cometabolic processes to treat ground water contaminated with chlorinated solvent mixtures. ESTCP supported a 3-year field study to investigate single-well tests to evaluate the potential for aerobic cometabolism of CAHs. Tests were performed at McClellan Air Force Base (AFB), CA, using propane as the cometabolic substrate, and at Fort Lewis Logistics Center, WA, using toluene as the cometabolic substrate. McClellan AFB was selected as a demonstration site due to significant CAH groundwater contamination, and it served as the site of the ESTCP demonstration of cometabolic air sparging with propane as a growth substrate. In the Fort Lewis demonstration, toluene was evaluated as a cometabolic growth substrate, and different surrogates and inhibitors were evaluated. The single-well test methods were developed and demonstrated to determine (1) the transport characteristics of nutrients, substrates, and CAHs and their transformation products; (2) the capability of indigenous microorganisms to utilize selected substrates and transform targeted contaminants and surrogate compounds; (3) the rates of substrate utilization and contaminant transformation; and (4) the combinations of injected nutrients and substrates that maximize rates of contaminant transformation. <http://handle.dtic.mil/100.2/ADA468544>

Quantifying PCE and TCE in DNAPL Source Zones: Effects of Sampling Methods Used for Intact Cores at Varied Contaminant Levels and Media Temperatures

Siegrist, R.L., K.S. Lowe, M.L. Crimi, and M.A. Urynowicz.

Ground Water Monitoring & Remediation, Vol 26 No 2, p 114-124, Spring 2006

A study was completed to assess the impact of sampling methods, contaminant levels, and subsurface temperatures on the quantification of PCE and TCE in DNAPL source zones. Intact cores of clean aquifer solids from a DNAPL site were spiked with neat PCE and TCE to yield concentrations such that DNAPL-phase contamination would be absent or present. Three methods characterized by different levels of media disaggregation and atmospheric exposure (MDE) were used to obtain samples from intact cores, which were at temperatures of 2, 20, and 38 degrees C. The results demonstrated that sampling of intact cores can yield negative bias, ranging from 0 to 98% or more, in the concentrations of PCE and TCE measured. Larger negative bias was correlated with higher MDE methods, presumably due to elevated volatilization losses during sample collection and containerization. Larger negative bias was also correlated with higher temperatures but only during sampling using higher MDE methods. The results of this study suggest that intact core sampling procedures have the potential to lead to erroneous conclusions about a DNAPL source zone.

Quantitative Determination of 1,4-Dioxane and Tetrahydrofuran in Water by Activated Carbon Solid Phase Extraction GC-MS/MS

Isaacson, Carl and Jennifer A. Field, Oregon State Univ.

Subsurface Biosphere Initiative Workshop/ IGERT Retreat, 18-21 June 2006, Oregon State University. Poster presentation, 2006

The environmental fate and transport of oxygenated solvent stabilizers (e.g., 1,4-dioxane and tetrahydrofuran [THF]) in groundwater is poorly understood, but limited observations indicate that these compounds are the most readily transported contaminants in plumes of chlorinated solvent and mixed waste. The compounds also are not readily biodegraded. Quantitative determination of these compounds in water is complicated by their physical

chemical properties (e.g., high water solubility, low K_{ow} and Henry's Constant). A quantitative analytical method was developed for the determination of dioxane and THF based on activated-carbon solid-phase extraction. The quantitation limit of the method is 0.31 ug/L for 1,4-dioxane and 3.1 ug/L for THF, based on signal to noise of 10/1. Spike and recovery experiments (n=5) yielded 98% and 95% recoveries for dioxane and THF, respectively, with precision as determined by relative standard deviation of 1.8% and 5.5% for THF, all while using only 1.2 mL of solvent. The method was applied to samples from mixed solvent and chlorinated solvent contaminated sites.

Rapid Analysis of Polychlorinated Biphenyls in the Gas Phase with Resonance-Enhanced Two-Photon Ionization: Optimal Injection of Ions into the Ion-Trap Storage/Time-of-Flight Mass Spectrometer

Dobashi, S., M. Kira, R. Tanaka, Y. Izawa, Y. Deguchi, T. Kubota, A. Wada, and M. Hara. Analytical Sciences, Vol 21, p 1111-1115, Sep 2005

LI-IT-TOFMS (laser ionization/ion-trap storage/time-of-flight mass spectrometry) is expected to be a powerful tool for environmental monitoring. In the research reported here, real-time LI-IT-TOFMS measurements were carried out on gaseous 2-4 chlorinated PCBs to evaluate the applicability of an environmental monitoring method. With respect to ion-trap storage for PCBs, the investigators found that the effect was due to the driving RF voltage on the ring electrode in the ion trap. For PCBs ions produced by laser irradiation, it was more efficient to reach the center of the ion trap using a gated RF voltage rather than a continuous RF voltage. The ion trajectories in the ion trap were simulated by SIMION 7.0. The voltage of the exit end cap electrode affected both the number of ions trapped and the orbit of ions inside the trap cell. Optimization of this parameter was performed using both simulated and experimental results. The achievable PCB sensitivity for real-time (1 min) measurement using the LI-IT-TOFMS method was in the pptV range (<0.01 µg/m³N). A satisfactory proportional relationship was confirmed between the laser-based and conventional gas sampling/GS-MS method results.

http://www.jstage.jst.go.jp/article/analsci/21/9/1111/_pdf

Rapid Estimation of TPH Reduction in Oil-Contaminated Soils Using the MED Method

Edenborn, H.M. and V.A. Zenone, U.S. EPA, Philadelphia, PA.

Proceedings of the Ninth International In Situ and On Site Bioremediation Symposium. Battelle Press, Columbus, OH. ISBN 978-1-57477-161-9, Paper 178, 2007 [DOE/NETL-IR-2007-142]

Oil-contaminated soil and sludge generated during federal well-plugging activities in northwestern Pennsylvania currently are remediated on small land-farm sites in lieu of more expensive landfill disposal. Bioremediation success at these sites in the past has been gauged by the decrease in total petroleum hydrocarbon (TPH) concentrations to less than 10,000 mg/kg measured using EPA Method 418.1. Investigators tested the molarity of ethanol droplet (MED) water repellency test as a rapid indicator of TPH concentration in land-farm soil. MED was estimated by determining the minimum ethanol concentration (0 to 6 M) required to penetrate air-dried and sieved soil samples within 10 seconds. TPH in soil was analyzed by rapid fluorometric analysis of methanol soil extracts, which correlated well with EPA Method 1664. Uncontaminated land-farm soil amended with increasing concentrations of waste oil sludge showed a high correlation between MED and TPH. MED values exceeded the upper limit of 6 M as TPH estimates exceed ~25,000 mg/kg. MED and TPH at the land farm were sampled monthly

during summer months over two years in a grid pattern that allowed spatial comparisons of site remediation effectiveness. MED and TPH decreased at a constant rate over time and remained highly correlated. Inexpensive alternatives to reagent-grade ethanol gave comparable results. The simple MED approach served as an inexpensive alternative to the routine laboratory analysis of TPH during the monitoring of oily waste bioremediation at the land-farm site.

Paper at <http://www.osti.gov/bridge/servlets/purl/915479-v96AHw/915479.PDF>

Refinery Evaluation of Optical Imaging to Locate Fugitive Emissions

Robinson, D.R., R. Luke-Boone, V. Aggarwal, et al. [11 more authors]

Journal of the Air and Waste Management Association, Vol 57 No 7, July 2007

This paper discusses a refinery evaluation of an optical imaging instrument that is based on infrared backscatter absorption gas imaging technology. The video camera allows an operator to scan components more quickly and in real time. The instrument was able to identify 97% of the total mass emissions being released at the site. More than 27,000 components were monitored. This inspection was achieved in far less time than it would have taken using the normal Method 21. Also it identified leaks that were occurring from components that are not required to be monitored by the current regulations. The paper also discusses how the technology works.

Remote Detection of Chemicals with Passive Millimeter Waves

Gopalsami, N., S. Bakhtiari, T. W. Elmer, and A. C. Raptis.

Chemical and Biological Sensors for Industrial and Environmental Monitoring II.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6378, 2006

A radiative transfer model was developed to determine the detection feasibility and system requirements for passive millimeter-wave (mmW) spectral detection. A Dicke-switched multispectral radiometer that operates at 146-154 GHz was designed and built for remote detection of stack gases. The radiometer was tested in the laboratory using a gas cell; the spectra of acetonitrile were detected passively against a cold background, which mimicked typical remote detection scenarios in the field. With Dicke-switched integration of radiometric signals, on-line calibration, and novel signal processing to minimize atmospheric fluctuation, spectral line detection of polar molecules is possible from chemical plumes a few kilometers away.

The Role of Bacterial Nanowires on Naturally-Occurring Electrical Fields

Hill, E.A. (Pacific Northwest National Lab, Richland, WA); D. Ntarlagiannis (Rutgers Univ., Newark, NJ); E.A. Atekwana (Oklahoma State Univ., Stillwater); Y.A. Gorby (J. Craig Venter Inst., La Jolla, CA).

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract NS51A-06, 2007

Microbial activity is shown to contribute significantly to the naturally occurring electrical fields observed in geologic media. To investigate the source mechanism of this phenomenon, investigators constructed models of the subsurface in saturated sand columns inoculated with *Shewanella oneidensis* MR-1 and a mutant strain as control. *S. oneidensis* is known to develop a structured network of electron-conductive bacterial nanowires as a response to electron acceptor limitation conditions. Strong voltage gradients (SP) were observed with redox potential gradients in the MR-1 column but were absent in the mutant columns. It is hypothesized that deeply

submerged (suffocating) cells gain access to oxygen through a nanowire network that extends to the groundwater/atmospheric air interface. The nanowires serve as conduits for transfer electrons from bacteria in the anaerobic part of the column to bacteria at the surface that have access to oxygen. This process may be directly linked with SP and redox gradients that develop across the column. In the absence of conductive nanowires (or other conductors), redox potential gradients do not necessarily promote SP gradients. The results suggest that microbial activity and nanowires affect the electrical properties of porous materials.

Room Temperature Detection of Chemical Pollutants by SnO₂-Based Optical Fiber Sensors
Consales, M., M. Pisco, P. Pilla, A. Cutolo, A. Buosiccolo, R. Viter, V. Smyntyn, M. Giordano, and A. Cusano.

Optical Sensing Technology and Applications. Proceedings of SPIE—The International Society for Optical Engineering, Volume 6585, 2007

An SnO₂-based optical fiber sensor is proposed for room-temperature detection of chemical pollutants in air. Particle layers composed of tin dioxide grains, with wavelength and subwavelength dimensions, provided promising results. The sensors are able to modify the optical near field profile emerging from the film surface significantly due to local enhancements of the evanescent wave contribution, and thus improve sensitivity to surface effects induced by the analyte interaction. The room temperature-sensing performances of SnO₂-based particle layers for environmental pollutants has been investigated by exposure to different concentrations of toluene and xylene vapors, as well as gaseous ammonia. Their performance also has been compared with that obtained with other optical fiber sensors in the same configuration but coated with different sensitive materials, such as single-walled carbon nanotubes. The preliminary results evidence a surprising capacity of the SnO₂-based optical sensor to detect chemical pollutants at ppm levels in air at room temperature.

Sampling Household Surfaces for Pesticide Residues: Comparison between a Press Sampler and Solvent-Moistened Wipes

Bernard, C.E., M.R. Berry, L.J. Wymer, and L.J. Melnyk, U.S. EPA, Cincinnati, OH.
Science of the Total Environment, Vol 389 Nos 2-3, p 514-521, 25 Jan 2008

The conventional way to test indoor surfaces for contaminants is with sponges or gauze pads that have been wetted with an organic solvent. Although good results are obtained this way, the technique is limited to solvents that do not damage or discolor household surfaces. In addition, uniformity during sampling by wiping is inherently difficult to maintain. Scientists at U.S. EPA's National Exposure Research Lab in Cincinnati examined an alternative sampling system, based on a press sampler. This device consists of a Teflon block of dimensions 20 x 11 x 9.5 cm weighing about 1300 g, simulating the force of a child's hand while crawling on the floor. It operates simply by contacting the surface to allow transfer to the sampling disks, which are sandwiched between the base of the device and a removable plate. Sections of ceramic tile, hardwood flooring, vinyl tile and low-pile carpet were sprayed uniformly with one of several pesticide sprays containing chlorpyrifos, malathion, fipronil, permethrin, cyfluthrin, cypermethrin, and deltamethrin, then sampled with cotton wipes pre-wetted with isopropanol or with the press sampler employing cotton, polyurethane foam (PUF), or Empore C18 extraction disks as the sampling material. The trapped pesticides were removed by accelerated solvent extraction for analysis by gas chromatography with electron capture detection. Pesticide transfers

from the hard surfaces using the press sampler were approximately the same, allowing their grouping into one category. Transfer was roughly 10-fold higher from the hard surfaces than from carpet. The mean transfer efficiencies for the organophosphorus pesticides for hard surfaces were 17-55%, 6-27% and 5-30% for C18, cotton and PUF, respectively. The corresponding values for the pyrazole and permethrin pesticides were poor at 3%, 2-3% and 1-2%, respectively. The figures were much lower for carpet for all of the pesticides. These poor transfer figures contrasted sharply with those for the isopropanol-wetted wipes, which were 84-97% and 31-39% for hard surfaces and carpets, respectively, for all pesticides. Even though the transfer efficiency varied with surface type and pesticide class, the wipes gave a far better performance than the press sampler for carpets as well as hard surfaces, although the transfer efficiency, while acceptable, is still on the low side.

Sampling in the Smear Zone: Evaluation of Nondissolved Bias and Associated BTEX, MTBE, and TPH Concentrations in Ground Water Samples

Zemo, Dawn A.

Ground Water Monitoring & Remediation,

Volume 26 Issue 3 Page 125-133, Summer 2006

This study looks at groundwater analytical data from 47 gasoline release sites. The author found that the data were often biased high because the well was screened in the smear zone and this fact was not necessarily taken into account in the data analysis. Samples gathered in wells screened across the smear zone can have higher values because of contributions from entrained nondissolved petroleum constituents. A first step in checking for bias is to compare the collected data with the constituents published solubility number. Also smear zone duplicate sample concentrations often are not comparable. The frequency of nondissolved bias in the groundwater monitoring data reported for the 47 sites ranged from 0.4% to 86%. If exceedances of the average concentration values for the laboratory testing of samples having sheen (a correction for potential weathering bias) are used, the frequency ranged from 9% to 20%. The author concludes that the evaluation shows that a significant percentage of groundwater monitoring data collected from the smear zone is unreliable for characterizing dissolved concentrations of petroleum constituents.

Sampling Strategies for Volatile Organic Compounds at Three Karst Springs in Tennessee

Williams, Shannon D., William J. Wolfe, and James J. Farmer

Ground Water Monitoring & Remediation, Vol 26 No 1, p 53-62, Feb 2006

The influence of different sampling strategies on characterizing volatile organic compound (VOC) concentrations and estimating VOC loads was evaluated at three karst springs in Tennessee over a 6-month period. Water samples for VOC analyses were collected weekly at all three springs and as frequently as every 20 min during storms at the two springs with variable water quality conditions. Total 6-month loads for selected VOCs were calculated, and VOC data were systematically subsampled to simulate and evaluate several potential sampling strategies. Results from the study indicate that sampling strategies for karst springs need to be developed on a site-specific basis. The use of fixed sampling intervals (as infrequently as quarterly or semiannually) produced accurate concentration and load estimates at one of the springs; however, additional sampling was needed to detect storm-related changes at a second spring located in a similar hydrogeologic setting. Continuous discharge data and high-frequency or

flow-controlled sampling were needed at the third spring, which had the most variable flow and water quality conditions. The lack of continuous discharge data at the third spring would substantially affect load calculations, and the use of fixed sampling intervals would affect load calculations and the ability to detect pulses of high contaminant concentrations that might exceed toxicity levels for aquatic organisms.

A Second Look at the Palmes' Diffusive Sampler

Busbin, D.D., C.E. Feigley, D.W. Underhill, and D. Salzberg, Univ. of South Carolina, Columbia.

Journal of the Air & Waste Management Association, Vol 56 No 10, Oct 2006

Although the Palmes tube has been widely used in determining air pollutant concentrations, especially for nitrogen dioxide, the current literature regarding Palmes tubes gives inconsistent sampling rates, throwing into doubt the many results obtained with this device. Using a novel procedure involving evaporation of volatile liquid from a Palmes tube, mass transfer was found to be highly affected by eddy diffusion as a function of both wind speed and incidence angle. Within certain bounds, acceptable results should be obtainable by accounting for the effects of wind speed and incidence angle on the sampling rate.

Sediment Toxicity Identification Evaluation (TIE): Phases I, II, and III Guidance Document

Ho, K.T., R.M. Burgess, D.R. Mount, T.J. Norberg-King, and J.R. Hockett, U.S. EPA.

EPA 600-R-07-080, 145 pp, Sep 2007

This document provides guidance on the performance of sediment toxicity identification and evaluation (TIE) methods. TIE methods allow for the identification of toxic chemicals or chemical classes causing observed toxicity. The identification of pollutants responsible for toxicity of contaminated sediments has broad application in EPA programs as the methods can be used within the total maximum daily load (TMDL) framework, to link sediment toxicity to specific dischargers, to design cost-effective remediation programs, and to identify environmentally protective options for dredged material disposal. In addition, the identification of specific problem contaminants in sediments could prove useful to EPA programs involved in the development of water or sediment quality guidelines and the registration of new products, such as pesticides. Knowledge of the causes of toxicity that influence ecological changes such as community structure would be useful in performing ecological risk assessments, not only for the Agency, but also for the scientific and regulated community as a whole. This document provides guidance for both interstitial water and whole sediment TIEs and combines current EPA understanding of TIE methods for both marine and freshwater interstitial waters and whole sediments. This guidance does not include approaches for the implementation of sediment TIE in a regulatory context. Phase I TIE (characterization) methods are provided for interstitial waters and whole sediments, including guidance on when to use whole sediment or interstitial water methods, the collection of interstitial waters for testing, and test volume considerations. Interstitial water methods include the following manipulations: graduated pH, aeration, filtration, C18 reverse-phase chromatography extraction, EDTA addition, and cation exchange solid-phase extraction. Whole sediment methods include general procedures and considerations for whole sediment testing and the following manipulations: *Ulva lactuca*, zeolite, cation exchange resin, anion exchange resin, acid volatile sulfide, Amborsorb, and powdered coconut charcoal additions and base metal substitution. Existing guidance for Phase II and III methods has been tailored for

chemical classes normally found in sediments.

<http://epa.gov/nheerl/publications/files/Sediment%20TIE%20Guidance%20Document.pdf>

Selection of an Averaging Technique by Simulation Study of a DIAL System for Toxic Agents Monitoring

Dudeja, J.P., M.K. Jindal, and S. Veerabuthiran.

Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing III.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6750, 2007

Differential absorption Lidar (DIAL) is a very effective technique for standoff detection of various toxic agents in the atmosphere. The Lidar backscattered signal received usually has poor signal-to-noise (SNR) ratio. Statistical averaging over a number of laser pulses is used to improve the SNR. The authors discuss the selection of a particular statistical averaging technique that is suitable for removing the noise in Lidar return signals. The DIAL system considered here uses laser transmitters based on OPO based (2-5 μm) and TEA CO₂ (9-11 μm) lasers. Eight commonly used chemical warfare agents—five nerve agents and three blister agents—are provide examples of toxic agents. Graphical user interface (GUI) software has been developed in LabVIEW to simulate return signals mixed with the expected noise levels. A toxic agent cloud with a given thickness and concentration has been assumed to be detected in the ambient atmospheric conditions at various ranges up to 5 Km, and number concentrations of the particular agent have been computed and compared with ideal Lidar return signal values. The exercise was repeated for all the eight agents and the most suitable averaging technique has been selected based on the results obtained.

Selective Method for the Analysis of Perchlorate in Drinking Waters at Nanogram per Liter Levels, Using Two-Dimensional Ion Chromatography with Suppressed Conductivity Detection Wagner, H.B. (Lakeshore Engineering Services, Inc., Cincinnati, OH); B.V. Pepich (Shaw Environmental, Inc., Cincinnati, OH); C. Pohl, D. Later, K. Srinivasan, R. Lin, and B. DeBorba (Dionex Corporation, Sunnyvale, CA); and D.J. Munch (U.S. EPA, Cincinnati, OH).
Journal of Chromatography A, Vol 1155 No 1, p 15-21, 29 June 2007

In 2005, EPA published three analytical methods—314.1, 331.0 and 332.0—for perchlorate in drinking water to address the interest in increasing sensitivity and selectivity for the analysis of perchlorate. In 2006, an automated 2D ion chromatography (IC) method was developed for measuring perchlorate with suppressed conductivity detection—essentially an automated column concentration and matrix elimination technique. In the first dimension, a large sample volume is injected onto a first separation column and the separated matrix ions are diverted to waste while the analyte(s) of interest are selectively cut, trapped, and concentrated in a concentrator column. In the second dimension, the contents from the concentrator column are eluted onto a second analytical column for separation and quantitation of the analyte. Incorporation of two columns with different affinities for the analyte in a single analysis can provide comparable selectivity and superior sensitivity to a method using second column confirmation in a second separate analysis step. This approach has been improved upon by the development of a new, highly sensitive and selective 2D-IC suppressed conductivity method with a lowest concentration minimum reporting level of 55 ng/L for perchlorate in drinking water samples. This new method has comparable sensitivity and selectivity and is simpler and

more economical than IC-mass spectrometric (MS) or IC-MS/MS techniques. The method is being prepared for publication as EPA Method 314.2.

Serbia and Denmark Approve Field Trial of GM Plants for the Detection of Explosives in Soil
FarmToday.com, 30 Aug 2007

The authorities in Serbia and Denmark are permitting field trials of Arabidopsis plants that can be used to detect the presence of explosives and landmines in the soil. The deliberate release will take place in an area close to Novi Sad in Serbia, and will be conducted in cooperation with the agricultural institute NS Seme in Novi Sad. Trials will also be conducted in Jægerspris, Denmark. This demonstration will further the development of a landmine detection plant, a biosensor labeled RedDetect(tm), by Aresa. The explosive inside a landmine contains material that releases nitrogen dioxide when it has been in the ground for a period of time. The genetically modified plant can sense nitrogen dioxide in soil, and it changes color from green to red when growing on or in near proximity to landmines. Aresa plans to transfer the RedDetect(tm) technology to a tobacco plant by 2008 to increase the robustness of the technology, as well as its commercial potential. Aresa is a plant biotech company established in 2001, as a spin-off from the Institute of Molecular Biology at the University of Copenhagen.

Simple Photometric Determination of Free Cyanide Ion in Aqueous Solution with 2,6-Dichlorophenolindophenol

Yari, Abdollah (Lorestan Univ., Khorramabad, Iran) and Kazem Kargosha (Iranian Center of Chemical & Chemical Engineering Research, Tehran).
Central European Journal of Chemistry, Vol 4 No 2, p 329-337, 2006

A simple photometric method with high accuracy and precision for measuring trace amounts of free cyanide ion in aqueous solution determined CN⁻ concentration in the range of 5 to 70 ppm easily under the evaluated conditions. The work is based upon the photometric titration of CN⁻ with Co(II) in the presence of 2,6-dichlorophenolindophenol in aqueous solution. The authors discuss the optimal analytical conditions, as well as the interference effect of other cations and anions. The optimized titration was used successfully to determine the concentration of free cyanide ion in aqueous solutions.

Simultaneous Determination of Pesticides, Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls in Seawater and Interstitial Marine Water Samples, Using Stir Bar Sorptive Extraction-Thermal Desorption-Gas Chromatography-Mass Spectrometry
Perez-Carrera, E., V.M. Leon Leon, A. Gomez Parra, and E. Gonzalez-Mazo.
Journal of Chromatography A, Vol 1170 Nos 1-2, p 82-90, 2 Nov 2007

A new method for the simultaneous determination of SVOCs (polycyclic aromatic hydrocarbons, polychlorinated biphenyls, organochlorine and organophosphorus pesticides) in marine samples has been developed using the stir bar sorptive extraction technique (SBSE) and thermal desorption coupled to capillary gas chromatography/mass spectrometry (SBSE-TD-GC/MS). Polydimethyl siloxane (PDMS) was used for the extraction of the selected analytes, and two procedures have been optimized and validated, one for seawater samples (100 mL) and another for interstitial water samples (10 mL), using PDMS stir bars of 20 mm and 10 mm size, respectively. The proposed methods are sensitive, simple and show good linearity and detection

limits lower than 1 ng/L with seawater and lower than 10 ng/L with interstitial marine water for the majority of compounds tested.

Simultaneous Monitoring of PCDD/Fs and PCBs in Contaminated Air with Semipermeable Membrane Devices and Fresh Spruce Needles

Zhu, X. (Dalian Jiaotong Univ., Dalian, China), G. Pfister, B. Henkelmann, J. Kotalik, S. Fiedler, and K.W. Schramm.

Chemosphere, Vol 68 No 9, p 1623-1629, Aug 2007

Air contaminated with burning plastic flooring and electronic scrap was monitored simultaneously with semipermeable membrane devices (SPMDs) and fresh unpolluted spruce needles for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) and polychlorinated biphenyls (PCBs). More PCDFs than PCDDs were collected from the contaminated air. The total amount of PCBs was much higher than those of PCDD/Fs. The triolein-containing SPMDs absorbed a much greater amount of PCDD/Fs and PCBs than the spruce needles during the simultaneous exposures; however, the logarithm of the concentrations of PCDD/Fs and PCBs in the SPMDs and the spruce needles exhibited a significant linear correlation, which suggests that SPMDs and spruce needles can complement each other in passive air sampling.

Smog Analysis in Urban Areas Using ASTER Data and Its Analysis of Variance with In-Situ Sensors Data

Roy, P., J.O. Brumfield, and A. Vaseashta

Nanotech 2007: Technical Proceedings of the 2007 NSTI Nanotechnology Conference and Trade Show. NSTI: Nano Science & Technology Institute, ISBN: 1-4200-6183-6, Vol 2, p 631-634

An approach to assess atmospheric pollutants in the troposphere and their spectral characteristic signatures is reported on in this paper. The approach uses high-spectral and spatial resolution ASTER data and its analysis of variance with in-situ data obtained using ground based sensors. The objective of this investigation is to create a model to observe the transport of air pollutants from their source, using high spectral and spatial resolution ASTER band in SWIR and TIR ranges and in-situ pollutants concentration data provided by EPA air quality monitoring stations and facilities emission data. The spatial resolution of the imagery is increased by use of Data Fusion techniques. By using an 'Analysis of Variance' from city to city, the work is progressing towards developing a correlation between the EPA sensors data and the ASTER pixel reflectance digital numbers, in all possible absorption bands.

Strategies for Designing Ground Water Monitoring Networks at Waste Storage Facilities with Multiple Source Areas

Hudak, Paul F.

Ground Water Monitoring & Remediation,

Volume 26 Issue 3 Page 77-81, Summer 2006

The paper describes the use of a computer model to evaluate four monitoring well configurations to monitor potential releases from multiple sources. The results of the model indicate that a network without monitoring redundancy in overlapping source areas, with wells

spaced uniformly perpendicular to ground water flow, outperformed alternative layouts. Perpendicular networks were also more robust to uncertain model parameters.

Subsurface Geophysical Exploration Within and Around Hanford's Tank Farms: Examples from T and S Farm

Levitt, Marc, Colin Henderson, Chris Baldyga, Brian Cubbage, Shawn Calendine, and Dale Rucker

Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007

Activities at Hanford site resulted in the release of inorganic liquids such as bismuth phosphate, nitric acid, sulfuric acid, and sodium hydroxide. These liquids, due to their ionic strength, are highly conductive relative to the electrically resistive sand that is pervasive throughout the complex. To understand the fate and transport of these inorganic solvents, a geophysical exploration, which mainly included high resolution resistivity (HRR) and electrical resistivity inversion, was conducted. The exploration area is highly complex and includes pipes, tanks, wells, fences, and other cultural features that present problems for geophysical techniques. To overcome the geophysical challenges, the infrastructure was used in the measurement process. For example, vadose zone monitoring wells and groundwater wells were used as both current transmission and voltage measurement points for resistivity measurements, and the data were modeled to recreate the distribution of electrical properties. These electrical properties were then related to the distribution of waste through petrophysical relations that relate analyte concentration to resistivity. The results of the survey showed that coincident surface resistivity conducted over areas with few infrastructural interferences adjacent to the tank farm compared favorably with resistivity data obtained using the infrastructure (wells).

Subsurface Hydrological Monitoring of a Watershed with Hybrid Sensor Networks

Koch, J.R. and S. Sedigh Sarvestani (Univ. of Missouri-Rolla); E. Atekwana (Oklahoma State Univ., Stillwater).

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract NS31B-06, 2007

This paper describes novel instrumentation for in situ hydrological monitoring of watersheds that autonomously measures various attributes of the watershed soil, including chemical composition, moisture, temperature, and resistivity. Measurements are taken at several depths and communicated to a processing server. The system comprises a network of sensor strings, each of which connects up to 100 sensing nodes on a communication line that can be up to 100 m in length. Each of the nodes contains the sensors needed for measuring soil attributes of interest, as well as a microcontroller with basic communication and processing capabilities. Ultra-low power design and remote maintenance provide for an unattended field life of over 5 years. The system is scalable in area and sensor modality; covering a larger area would entail only the addition of sensor strings, and the nodes are designed to facilitate the interfacing of additional sensors. The system is robust, as the only exposed portion is the relay point. Data collection and transmission can be event driven or time driven. Battery power (which can be supplemented with solar power) and wireless short- and long-range communication eliminate the need for surface wiring and significantly reduce the cost of system deployment. The cost for each sensor string is currently estimated at less than \$30 for small batch production, which compares very favorably to existing systems that have limited capabilities yet cost tens of thousands of

dollars. The proposed system has the potential to improve hydrological monitoring significantly by enabling the collection of data at a scale and resolution that is orders of magnitude greater than any existing method, while dramatically reducing the cost of monitoring.

Subsurface Imaging of an Abandoned Solid Waste Landfill Site in Norman, Oklahoma

Zume, Joseph T., Aondover Tarhule, and Scott Christenson.

Ground Water Monitoring & Remediation, Vol 26 No 2, p 62-69, Spring 2006

A leachate plume emanating from an old unlined municipal landfill site near the city of Norman, OK, is discharging into the underlying alluvial aquifer. Electrical resistivity tomography and electrical conductivity (EC) logging are subsurface imaging techniques used on site to detect and map the position of the leachate plume. The two methods delineated anomalous EC zones that correlated with the plume's location and extent as evidenced by water chemistry analyses from multilevel monitoring wells. Specific conductance, a potential indicator of leachate contamination, ranged from 1,861 to 7,710 uS/cm in contaminated zones and from 465 to 2,180 uS/cm in uncontaminated groundwater.

A Suction Bailer for Sampling Very Thin Saturated Zones

Hubbell, Joel M., James L. Osiensky, Michael J. Nicholl, and James B. Sisson.

Ground Water Monitoring & Remediation,

Volume 26 Issue 2 Page 52-57, Spring 2006

This paper evaluates a suction bailer for sampling very thin perched water bodies (on the order of 1 cm thick). The bailer has a semi-permeable membrane on the bottom that allows water entry, while blocking air. Three prototypes were constructed and tested; one is based on a commercial suction lysimeter, while the other two are fabricated from stainless steel. Sample sizes of 100–1,000 mL are possible and the sampler can be placed at any depth.

Surveying Ground Water Level Using Remote Sensing: An Example over the Seco and Hondo Creek Watershed in Texas

Chen, Pei-yu, Jeffrey G. Arnold, Raghavan Srinivasan, Martin Volk, and Peter M. Allen.

Ground Water Monitoring & Remediation,

Volume 26 Issue 2 Page 94-102, Spring 2006

The objective of this study was to assess the feasibility of using the Normalized Difference Vegetation Index (NDVI) response to plant water content to predict ground water levels. Within 10 days of the event, precipitation data collected inside the watershed lost their correlation to ground water depth, however, the NDVI derived from SPOT-VEGETATION satellite data and potential evapotranspiration (PET) based on the Hargreaves PET model were significantly correlated to ground water depth.. This study provides a unique approach to surveying ground water level based on satellite and meteorological data.

Three-Dimensional Multifluid Flow and Transport at the Brooklawn Site near Baton Rouge, LA: A Case Study

Oostrom, M., M.J. Truex, P.D. Thorne, and T.W. Wietsma.
Soil & Sediment Contamination, Vol 16 No 2, p 109-141, 2007

Three-dimensional simulations of DNAPL movement in the subsurface at the Brooklawn site were conducted using the STOMP simulator, including a new coupled well model. The modeling effort was conducted to determine the fate and transport of infiltrated DNAPL and measure the effects of active recovery through DNAPL pumping. A detailed 3D geologic model of the Brooklawn primary DNAPL disposal area was developed and used as the framework for DNAPL simulations. In addition to a simulation using the best available subsurface information, sensitivity simulations were conducted to assess the effects on DNAPL migration, including simulations for DNAPL pumping, well screen extension, an alternative geology, increased DNAPL density, lower DNAPL viscosity, and sand and silt deposits of greater permeability. Results of the simulations were compared to field data that define the extent of DNAPL movement based on where DNAPL has been extracted in the site recovery wells. The model simulations predict no significant reduction in the extent of the DNAPL as a result of pumping. Pumping returns diminish rapidly due to the limited radius of influence of the wells and movement of the DNAPL out of the zone of influence of the wells with a maximum radius of influence of about 6 m. The numerical analysis also indicates that it is impractical to extend existing wells or install new wells to retrieve enough DNAPL to affect the overall extent of DNAPL movement.

Tracking SERS-Active Nanoprobe Intracellular Uptake for Chemical and Biological Sensing

Gregas, M.K., F. Yan, J. Scaffidi, H.-N. Wang, C. Khoury, Y. Zhang, and T. Vo-Dinh.
Advanced Environmental, Chemical, and Biological Sensing Technologies V.
Proceedings of SPIE—The International Society for Optical Engineering, Volume 6755, 2007

The authors describe experiments using surface-enhanced Raman scattering (SERS) spectroscopy and mapping to track cellular uptake of plasmonics-active labeled nanoparticles. Three different Raman-active labels with positive, negative, and neutral charges were conjugated to silver colloidal nanoparticles to profile spatially and temporally intracellular delivery and tracking of nanoprobes during uptake in single mammalian cells. 1-D Raman spectra and 2-D Raman mapping were used to identify and locate the probes via their SERS signal intensities. Because Raman spectroscopy is very specific for identification of chemical and molecular signatures, the development of functionalized plasmonics-active nanoprobes capable of exploring intracellular spaces and processes can provide specific information on the effects of biological and chemical pollutants in the intracellular environment. The results indicate that this technique will allow study of when, where, and how these substances affect microbes and living organisms.

Two-Dimensional Detection of Underground Contamination and Buried Objects Using Cross-Well Radar

Serrano-Guzman, Maria F., Ingrid Padilla, and Rafael Rodriguez.
Radar Sensor Technology X. Proceedings of SPIE—The International Society for Optical Engineering, Volume 6210, 2006

This paper reports the development of a 2D flow and electromagnetic (EM) soilBed setup to assess and enhance cross-well radar (CWR) technology for the detection of DNAPL contamination and other target elements in variably-saturated soils subjected to transient flow

conditions. Loop antennas have been developed and tested for this purpose. Transmission and reflection measurements are evaluated to determine the antenna's reliability and optimize their performance in the 2D electromagnetic field. The measurements indicate that a 2D EM boundary condition may be imposed by placing two parallel perfectly reflecting metal plates along one of the dimensions of the soilBed setup. Transmission and reflection characteristics of the antennas vary with their method of construction. Results show a reliable and reproducible response from the loop antennas, but suggest some wave leakage and indicate that their design must be optimized. Measured variations in the transmission, reflection, and impedance in the presence and absence of a buried object suggest that the 2D EM soilBed setup using loop antennas can be applied to detect target elements in subsurface environments subjected to flow conditions. Future work will address the assessment of CWR technology as a non-invasive method for detection and monitoring of heterogeneously-distributed target objects in subsurface environments.

USDC Based Rapid Penetrator of Packed Soil

Bao, X., Y. Bar-Cohen, Z. Chang, S. Sherrit, M. Badescu, S. Du, T. Song, and T. Peterson. Smart Structures and Materials 2006: Industrial and Commercial Applications of Smart Structures Technologies. Proceedings of SPIE—The International Society for Optical Engineering, Volume 6171, 2006

To detect buried chemical containers or other objects embedded in soil and avoid possible damage to them, a penetrator was developed for packed soil that requires low penetration force (the force needed to push a rod probe into the soil). The design was based on the novel mechanism used by the ultrasonic/sonic driller/corer (USDC) developed jointly by scientists at the NDEAA lab at JPL and engineers at Cybersonics, Inc. A small free-flying mass inside the penetrator is energized by a piezoelectric transducer and impacts a rod probe on its shoulder at frequencies of several hundred hertz. The impacts help the probe to penetrate the packed soil with low pushing force. Preliminary tests show that a large reduction of the penetration force was achieved; the effects of the penetrator on plastic containers and other objects are minimal. The details of the design of the prototype penetrator and the results of performance tests are presented.

Use of Airborne Gamma-Ray Spectrometry for Environmental Assessment of the Rehabilitated Nabarlek Uranium Mine, Australia

Martin, P. and S. Tims (Environmental Research Institute of the Supervising Scientist (ERISS), Darwin, NT, Australia); A. McGill (Northern Territory Dept. of Business, Industry & Resource Development, Darwin, NT, Australia); B. Ryan and K. Pfitzner (ERISS). Earth and Environmental Science, Vol 115 Nos 1-3, p 531-554, Apr 2006

This article describes an airborne gamma survey of a 7 by 5 km region around a rehabilitated uranium mine. An unusually tight line spacing (100 m) and low aircraft height (50 m) enabled the survey to distinguish creek lines and man-made structures, such as ponds and accommodation areas. Positive correlations between airborne data and ground-based readings enabled an estimation of the average absorbed dose rate arising from terrestrial gamma radiation over large areas of the site to be derived. For the fenced mine site area, this estimate was 0.31 uGy/hr. The airborne survey data were invaluable in helping to plan further ground-level investigations and showed promise as an assessment tool for rehabilitated minesites.

Use of Chlorofluorocarbons in Hydrology: A Guidebook

IAEA STI/PUB/1238, 277 pp.; 111 figures; June 2006, ISBN 92-0-100805-8,

Development of the chlorofluorocarbon (CFC) technique as a tool for dating groundwater has occurred over approximately the last 20 years, and a number of research publications have documented its use in specific aquifers. This publication is intended to facilitate a comparative analysis of CFC and isotope techniques and a wider use of the CFC technique under appropriate conditions by providing a description of its scientific basis, sampling and measurement methods, interpretation and limitations of data, and a variety of case studies.

http://www-pub.iaea.org/MTCD/publications/PDF/Pub1238_web.pdf

Use of Electrical Imaging and Microscopy to Evaluate Distribution of Injected Nano-Scale Zero Valent Iron

Elliott, D., E. Sullivan, and C. DelMonico (The Whitman Companies, Inc., East Brunswick, NJ); E.C. Hince (Geovation Consultants, Inc., Florida, NY).

The 22nd Annual International Conference on Contaminated Soils, Sediments and Water, 16-19 October 2006, University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. CD-ROM, Poster presentation, 2006

Using pneumatic and hydraulic fracturing techniques, nano-scale zero valent iron (nZVI) in an emulsified soy oil product was injected into a low permeability silty unit to promote dual abiotic and biotic degradation of TCE. A sand aquifer overlies the silt unit. To determine the effectiveness of the emulsion distribution in the subsurface, pre and post-injection Electrical Imaging (EI) surveys and groundwater microscopy samples were compared. Electrical imaging does not provide a unique solution to existing conditions but it is very good at detecting changes in conductivity/resistivity. The silty unit was too deep for the EI survey to reach but an increase in resistivity was noted in the sand aquifer interval just above the silt unit. The nZVI particles were observed via transmitted light microscopy and imaged with a CCD camera as angular, opaque objects ranging in size from less than 1 μm to approximately 5 μm indicating that significant aggregation has occurred. This technique indicated that the injection method was successful in placing the emulsion up to 25 feet away from the injection points.

Use of Geostatistics to Evaluate the Monitoring Well Network of a TCE Plume

Gross, Lori J., Tetra Tech NUS, Inc., Pittsburgh, PA.

International Journal of Environment and Pollution, Vol 29 No 4, p 370-382, 2007

Geostatistics were used to evaluate an existing network of wells in a groundwater monitoring program to determine whether selective well removal would result in a comparable characterization of a TCE plume. A second objective was to utilize public or commercial software to demonstrate the ease with which this analysis can be performed. After a baseline characterization was generated with the entire well network, subsequent simulations were performed with selected wells removed from the network. The exercise showed that the TCE plume could be characterized adequately without a significant increase in uncertainty when certain wells were removed from the monitoring network.

Use of Plume Mapping Data to Estimate Chlorinated Solvent Mass Loss

Barbaro, Jeffrey R. and Pradumna P. Neupane.

Ground Water Monitoring & Remediation,

Volume 26 Issue 4 Page 115-127, Fall 2006

A study was performed at Dover Air Force Base to determine the ability of plume mapping to assess the effectiveness of natural attenuation. Mass flux was calculated across two transverse plume cross sections and concentration changes were measured along a longitudinal cross section through the core of the plume. The plume mapping investigation determined the spatial distribution of chlorinated solvents migrating from former waste disposal sites. A direct push rig was used to set multilevel piezometers for vertical contaminant concentration profiles. Minipiezometers were placed in a downgradient stream bed to determine if contaminants were discharging into it. The field program showed that the plume, consisting of tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE), was approximately 670 m in length and 120 m in width, extended across much of the 9- to 18-m thickness of the surficial aquifer, and discharged to the stream in some areas. Losses of PCE and TCE were negligible downgradient of the source, while losses of cis 1,2-DCE were observed. The study demonstrated that plume mapping data can be used to estimate the occurrence and extent of chlorinated solvent mass loss from biodegradation.

The Use of the Induced Polarization (IP) Geophysical Method to Determine the Presence of NAPL in the Subsurface at a CN Rail Site

Nolan, K. J. and L. VanderKam, Earthtech.

Railroad Environmental Conference 2003 at University of Illinois at Urbana-Champaign, Abstracts, 2003

Petroleum nonaqueous-phase liquids (NAPLs) were suspected of being present in the subsurface of a rail site. Petroleum hydrocarbons have a dielectric constant that are at or below 2.2, in comparison to the 84.2 of water. Induced polarization (IP) is capable of detecting marked changes in dielectric constants in the subsurface. The purpose of the investigation reported in this paper was to determine if the IP geophysical technique would be effective in locating a subsurface NAPL that is in non-or low-electrolytic soils like sands and silty sands. The IP survey identified areas of elevated chargeability that correlated with zones suspected of having NAPL. Subsequent sampling in these areas showed that they contained NAPL. As a result this investigation shows that under some site conditions the IP geophysical method would be useful in quickly determining the presence of NAPL, and potentially reducing overall investigation time and costs.

Use of Remote Sensing in Reclamation Assessment at Teck Cominco's Bullmoose Mine Site

Straker, J., M. Blazecka, K. Sharman, S. Woelk, S. Boorman, and K. Kuschminder.

Mine Reclamation Symposium Proceedings. British Columbia Technical & Research Committee on Reclamation, CD-ROM, 7 pp, 2004

Using computer classification of satellite imagery to identify discrete vegetation units on the Bullmoose mine site, resulted in the definition of 10 vegetation classes on reclaimed coal waste areas. The defined classes are identifiable by unique spectral signatures. This information will be used to document the achievement of post-closure objectives on older reclaimed sites and to predict the success of more recent reclamation efforts, while reducing the need for more costly

and labor-intensive ground-based assessments. This paper summarizes the methods employed and results derived from this remote sensing-based assessment program.

http://www.trcr.bc.ca/docs/2004-straker_etal.pdf

Use of Stable Isotope Analysis to Assess Biodegradation of Volatile Organic Compounds in the Unsaturated Subsurface

Bouchard, Daniel, Ph.D. dissertation, University of Neuchatel, Switzerland. 141 pp, 2007

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

Dissertation at

http://doc.rero.ch/lm.php?url=1000,40,4,20070228162911-CU/these_BouchardD.pdf

Using a Battery of Bioassays, Benthic Phytoplankton and the AUSRIVAS Method to Monitor Long-Term Coal Tar Contaminated Sediment in the Cache la Poudre River, Colorado.

Oberholster, P.J., A.M. Botha, and T.E. Cloete

Department of Microbiology and Plant Pathology, University of Pretoria, Hillcrest, Pretoria Water Res. 2005 Dec; 39(20):4913-24

Ten locations in the Cache la Poudre River were surveyed for information on sediment toxicity and macroinvertebrates and benthic phytoplankton populations and diversity after long-

term exposure to coal tar residue. A biotest battery and the Australian river bioassessment system (AUSRIVAS) were used to evaluate the river conditions. Ecotoxicological studies were applied to organisms like *Selenastrum capricornutum*, *Daphnia magna* and *Chironomus tentans*, that represent different complexities in the biosphere. The results indicate that in principle a biotest battery and macroinvertebrate and benthic phytoplankton communities are suitable biological tools for evaluating the effects of toxic oil and coal-derived substances in contaminated river sediment.

Using Direct-Push EC Logging to Delineate Heterogeneity in a Clay-Rich Aquitard

Harrington, Glenn A. and M. Jim Hendry.

Ground Water Monitoring & Remediation,

Volume 26 Issue 1 Page 92-100, Winter 2006

This paper reports on the use of direct push-electrical conductivity (DPEC) logging to investigate the spatial variability of pore water salinity in a clay aquitard. The DPEC logging was conducted to a maximum depth of about 57 ft below ground surface (bgs). The results revealed complex spatial variations in the pore water salinity that ranged from <5,000 to ~90,000 $\mu\text{S}/\text{cm}$. The complex spatial distributions appear to be controlled by nonuniform salt fluxes from the unsaturated zone to the water table and subsequent downward diffusion. Very fine-grained sediments may limit the depth of penetration of the method.

Using Dissolved Hydrogen Measurements to Assess and Monitor Biodegradation of Chloroethenes in Ground Water

Cox, S.E., R.S. Dinicola, and R.L. Huffman, U.S. Geological Survey, Tacoma, WA.

Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma, Washington, 1-3 May 2007. p 101, 2007

Because of their significant influence on the occurrence and rate of chloroethene biodegradation, dissolved hydrogen concentrations have been monitored annually since 1996 in the chloroethene-contaminated groundwater beneath a former landfill at the Naval Undersea Warfare Center (NUWC), Division Keyport, WA. Groundwater oxidation-reduction (redox) conditions, defined as the predominant microbial terminal electron acceptor present in the aquifer, were also determined annually using dissolved hydrogen concentrations interpreted in the context of other redox-sensitive species, such as dissolved oxygen, nitrate, ferrous iron, sulfate, sulfide, and methane. Measurement of dissolved hydrogen has helped to identify areas favorable for different biodegradation processes. At NUWC, Division Keyport, dissolved hydrogen concentrations and redox conditions in many wells have varied considerably over time, but consistent spatial patterns and temporal trends were discernable. Areas where dissolved hydrogen concentrations exceeded 1 nanomole per liter have indicated regions of the strongly-reducing redox conditions that are most favorable for substantial biodegradation of high concentrations of chloroethenes. Changes in the extent of strongly reducing groundwaters over time have been identified, particularly beneath the part of the former landfill where pavement was removed to facilitate phytoremediation.

Using Groundwater Point Velocity Probes and Ground Penetrating Radar to Investigate Microbially Mediated Changes in Flow Properties of a Contaminated Aquifer

Schillig, P., M. McGlashan, J.F. Devlin, G. Tsoflias, and J. Roberts, Univ. of Kansas, Lawrence. Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract NS51A-02, 2007

The recently developed point velocity probe (PVP) measures centimeter-scale groundwater velocities directly. PVP velocity estimates are based on a mini tracer test completed around the circumference of a small cylinder emplaced in the aquifer. The PVP functions without a well and therefore requires no calibration. Velocity calculations are independent of Darcy's Law, thus eliminating the need for hydraulic gradients that usually can be measured only over scales much larger than those of local microbial effects. An array of multilevel PVPs instrumented in a flow gate in the Borden aquifer was coupled with borehole radar and tomographic methods. The PVPs were consistent in identifying changes in spatial heterogeneities apparently associated with the evolution of a petroleum hydrocarbon plume affected by stimulated biodegradation. Temporal changes in the heterogeneous properties of the aquifer were attributed to enhanced biological activity. Changing groundwater velocities corresponded spatially to areas of stimulant (oxygen release compound) application and plume attenuation.

Vadose Zone Monitoring System as a Tool for Groundwater Protection

Dahan, O., Univ. of the Negev, Midreshet Ben Gurion, Israel.

Eos: Transactions of the AGU, Vol 88 No 23, Joint Assembly Supl., Abstract H32B-02, 2007

A new vadose-zone monitoring system has been designed that provides continuous measurements of the soil water content and water potential while allowing pore-water sampling all along the vadose-zone cross section. The installation technique allows monitoring of the vadose-zone cross section under relatively undisturbed soil conditions. The new monitoring system consists of special flexible TDR probes assembled with special vadose-zone sampling ports that function either as deep vadose-zone tensiometers or pore-water sampling devices. The system is adapted for installation in small-diameter boreholes that allow multiple measurements of soil hydraulic properties all along the vadose-zone cross section, from land surface to groundwater. This monitoring system has been implemented in several studies on water infiltration and groundwater recharge in different climatic and lithological setups.

Validation of Three New Methods for Determination of Metal Emissions Using a Modified Environmental Protection Agency Method 301

Yance, C.A., D.C. Barth, K.A. Petterson, M.P. Nakanishi, J.A. Cooper, B.E. Johnsen, R.H. Lambert, and D.G. Bivins.

Journal of the Air & Waste Management Association, Vol 56 No 12, Dec 2006

Three new methods applicable to the determination of hazardous metal concentrations in stationary source emissions were developed and evaluated for use in U.S. EPA compliance applications. Two of the three independent methods, a continuous emissions monitor-based method (Xact) and an X-ray-based filter method (XFM), are used to measure metal emissions. The third method involves a quantitative aerosol generator (QAG), which produces a reference aerosol used to evaluate the measurement methods. The Xact and the XFM methods validated in this study include significant improvements in measurement technology and should enable plant operators to make more precise, accurate, and frequent measurements, leading to a better understanding of emissions. With the QAG, the new reference aerosol generator validated in this

study, development and evaluation of new measurement methods are now more practical. The measurement methods are applicable to a wide range of elements and may be applicable to other sources. The aerosol generator may be applicable to both organic and inorganic analytes.

Vapor Intrusion in Homes over Gasoline-Contaminated Ground Water in Stafford, New Jersey
Sanders, Paul F. and Ian Hers.
Ground Water Monitoring & Remediation,
Volume 26 Issue 1 Page 63-72, Winter 2006

This paper presents a case study of indoor air intrusion from a dissolved phase plume that originated from a gasoline release. The depth to groundwater in the sand aquifer was approximately 11 ft. Concentrations of BTEX in the water were as high as 82 mg/L and up to 590 mg/L for methyl-t-butyl ether (MTBE). Soil vapor samples were taken at multiple depths adjacent to several homes and on the main floor, in the basement, and under the foundation slab. One home had measurable impacts to indoor air quality that were attributable to the groundwater plume. In this house, MTBE, 2,2,4-trimethylpentane (isooctane), and cyclohexane were found in the indoor air, while the BTEX chemicals were not detected in the basement. The first two chemicals are an indication of an impact from the groundwater plume. The lack of BTEX can probably be attributed to biodegradation in the vadose zone. Attenuation factors (the ratio of the indoor air concentration to a source soil vapor concentration) for the BTEX chemicals between the ground water and the indoor air were $<1 \times 10^{-5}$, and for MTBE was 1.2×10^{-5} .

Volatile Organic Compounds Groundwater Plume Delineation Using Waterloo Profiler
Technology at the Tacoma Landfill
Taylor, Calvin and Eric Weber
Program and Abstracts: 6th Annual Washington Hydrogeology Symposium, Tacoma,
Washington, 1-3 May 2007

This presentation discusses the use of a Waterloo ProfilerTM to determine whether portion of plumes that were not reaching cleanup levels were residual plumes from the previous more extensive groundwater plumes or whether there was an ongoing source of contamination that was by-passing the point of compliance extraction wells. The profiler provided high quality samples at discrete intervals that were analyzed by an onsite laboratory with same day analytical results. The field work was completed over a two week period and provided the information needed to delineate the residual VOC plumes. In addition, the information gave additional support for a request to shutdown the offsite extraction wells.

Water and Surface Contamination Monitoring Using Deep UV Laser Induced Native
Fluorescence and Raman Spectroscopy
Hug, W.F., R. Bhartia, A. Tsapin; A. Lane, P. Conrad, K. Sijapati, and R.D. Reid.
Chemical and Biological Sensors for Industrial and Environmental Monitoring II.
Proceedings of SPIE—The International Society for Optical Engineering, Volume 6378, 2006

Reagentless water and surface sensors employing laser-induced native fluorescence (LINF) and resonance Raman spectroscopy (RRS) in the deep UV are making significant progress in detecting chemical and biological targets and differentiating them against a wide range of background materials. Methods for optimizing sensor performance for specific target

and backgrounds materials are discussed in relationship to closed industrial environments and open natural environments. Limits of detection and chemical specificity are discussed for high and low spectral resolution systems for a wide range of compounds and composite particles, such as spores and cells. Detection and identification of single spores is possible at a working distance of several meters. Sensors discussed include sample, sipper, and immersion sensors for water and fixed-point and scanner systems for surfaces. The use of UV LINF and RRS for detection in capillary electrophoresis and liquid chromatography is described with limits of detection in the range of a few nmol/L.

Water Security: Continuous Monitoring of Water Distribution Systems for Chemical Agents by SERS

Inscore, F., C. Shende, A. Sengupta, and S. Farquharson.

Optics and Photonics in Global Homeland Security III.

Proceedings of SPIE—The International Society for Optical Engineering, Volume 6540, 2007

The authors have developed a simple sampling device designed to optimize the interaction of the target molecules with the surface-enhanced Raman spectroscopy (SERS)-active material with the goal of increasing sensitivity and decreasing sampling times. This sampling device employs a syringe to draw the water sample containing the analyte into a capillary filled with the SERS-active material. The SERS-active capillaries have been used to measure 1 ppb cyanide in water. In this paper, these measurements are extended to nerve agent hydrolysis products using a portable Raman analyzer.