

## Measurement & Monitoring: 33<sup>nd</sup> Quarterly Literature Update & Grant Survey

The references selected for this update have been added to the searchable literature database developed for the Measurement and Monitoring Technologies for the 21<sup>st</sup> Century (21M<sup>2</sup>) Web site: [www.clu-in.org/programs/21m2/litsearch.cfm](http://www.clu-in.org/programs/21m2/litsearch.cfm)

1-Hydroxypyrene: A Biochemical Marker for PAH Pollution Assessment of Aquatic Ecosystem  
Blahova, J., K. Kruzikova, B. Kasikova, P. Stierand, J. Jurcikova, T. Ocelka, and Z. Svobodova.  
Sensors, Vol 10 No 1, p 203-217, 2010

A study was conducted to assess aquatic contamination by polycyclic aromatic hydrocarbons (PAHs) using the 1-hydroxypyrene (1-OHP) content in fish as a biochemical marker. The levels of 1-OHP in river fish were determined by reverse-phase HPLC with fluorescence detection after deconjugation. Normalizing the molar concentration of the biliary 1-OHP to the biliary protein content reduced sample variation. The content of 1-OHP was correlated with the PAH level in bottom sediment and semi-permeable membrane devices (SPMD) analyzed by a combination of HPLC/FLD and GC/MS methods. A Spearman correlation test was applied to determine the relationship between biliary 1-OHP and the sum of PAH in sediment and SPMD. A positive but not statistically significant correlation was found.  
<http://www.mdpi.com/1424-8220/10/1/203/pdf>

2009 DOE-EM Long-Term Monitoring Technical Forum Summary Report  
Mayer, J.

SRNL-RP-2009-00845, 54 pp, Sep 2009

The DOE-EM Long-Term Monitoring Technical Forum was held February 11-12, 2009, sponsored by Savannah River National Laboratory and DOE's Office of Environmental Management (EM) Engineering and Technology Program (EM-22). The Technical Forum was attended by 57 professionals with a focus on identifying areas of opportunity that would advance the transition of the current practices to a more effective strategy for long-term monitoring (LTM). The specific objectives were to identify (1) technical targets for reducing EM costs for life-cycle monitoring; (2) cost-effective approaches and tools to support the transition from active to passive remedies at EM waste sites; and (3) specific goals and objectives associated with lifecycle monitoring initiatives. The first breakout session focused on the integration and improvement of LTM performance measurement and monitoring tools that deal with parameters such as ecosystems, boundary conditions, geophysics, remote sensing, biomarkers, ecological indicators and other types of data used in LTM configurations. Three investment sectors were identified in this session. The second breakout session was focused on identifying new and inventive LTM systems that address the framework for interactive parameters like infrastructure, sensors, diagnostic features, field-screening tools, state-of-the-art characterization monitoring systems/concepts, and ecosystem approaches to site conditions and evolution. Two investment sectors were identified in this session. The last breakout session examined the development and implementation of novel information management systems for LTM, including techniques to address data issues, such as efficient management of large and diverse datasets; consistency and comparability in data management and incorporation of accurate historical information; data interpretation and information synthesis, including statistical methods, modeling, and

visualization; and linkage of data to site management objectives and leveraging information to forge consensus among stakeholders. One investment sector was identified in this session.

[http://www.osti.gov/bridge/product.biblio.jsp?query\\_id=4&page=0&osti\\_id=965900](http://www.osti.gov/bridge/product.biblio.jsp?query_id=4&page=0&osti_id=965900)

Active Ground Optical Remote Sensing for Improved Monitoring of Seedling Stress in Nurseries  
Eitel, Jan U., Robert F. Keefe, Dan S. Long, Anthony S. Davis, and Lee A. Vierling.  
Sensors, Vol 10 No 4, p 2843-2850, 2010

Active ground optical remote sensing (AGORS) devices mounted on overhead irrigation booms can be used for autonomous monitoring of plant stress. In contrast to traditionally used passive optical sensors, AGORS devices operate independently of ambient light conditions and do not require spectral reference readings. Besides measuring red (590-670 nm) and near-infrared (>760 nm) reflectance AGORS devices have recently become available that also measure red-edge (730 nm) reflectance. The authors tested the hypothesis that the additional availability of red-edge reflectance information would improve AGORS of plant stress-induced chlorophyll breakdown in Scots pine. Results showed that the availability of red-edge reflectance information improved AGORS estimates of stress induced variation in chlorophyll concentration ( $r^2 > 0.73$ , RMSE < 1.69) when compared to those without ( $r^2 = 0.57$ , RMSE = 2.11).

<http://www.mdpi.com/1424-8220/10/4/2843/pdf>

Adaptive Long-Term Monitoring at Environmental Restoration Sites: ESTCP Cost and Performance Report

Environmental Security Technology Certification Program (ESTCP), Project ER-0629, 59 pp, Nov 2009

The primary objective of Project ER-0629 was to demonstrate and validate the use of the Sampling Optimizer and Data Tracker software (from Summit Envirosolutions) at three DoD sites: the former George Air Force Base in Victorville, California; the former Nebraska Ordnance Plant in Mead; and the Camp Allen Landfill site in Norfolk, Virginia. MAROS (Monitoring and Remediation Optimization System) software also was applied at one of the three demonstration sites. The Summit software demonstrated in this ESTCP project provides a set of tools for long-term monitoring optimization, and consists of two major modules: (1) the Sampling Optimizer identifies redundant sampling locations (spatial optimization) or redundant locations and frequencies (spatiotemporal optimization) in historical data, and (2) the Data Tracker allows current monitoring data to be reviewed against selected historical data (i.e., background data) to identify cases where current data deviate from expectations based on the background values and patterns. This report provides the level of effort and computation time for applying the software at the demonstration sites, and a basis for estimating the costs of applying the software at other sites. A User's Guide for the software was finalized as part of this project and was prepared as a separate deliverable. The software and User's Guide are available for use at government sites by government personnel and their contractors.

<http://www.estcp.org/Technology/upload/ER-0629-C&P.pdf> User's Guide:

<http://www.estcp.org/Technology/upload/ER-0629%20User's%20Guide.pdf>

Analysis of Organic Contaminants in Dredged Material Using a Field-Portable GC-MS  
Bednar, A.J, R.A. Kirgan, J.M. Corbino, and A.L. Russell.  
Technical Note ERDC TN-DOER-E26, 9 pp, Sep 2009

This technical note describes the use of a field-portable gas chromatograph mass spectrometer for the in-field determination of organic contaminants in dredged material. During active dredging operations, sediment and water samples are collected as for traditional laboratory analysis of contaminants; however, in this case, field-portable instrumentation was used for quantitative analysis of certain organic contaminants, including polycyclic aromatic hydrocarbons. Technical note at <http://handle.dtic.mil/100.2/ADA508381>

Application and Evaluation of a New Passive Sampler for Measuring Average Solute Concentrations in a Catchment Scale Water Quality Monitoring Study  
Rozemeijer, J., Y.P. van der Velde, H. de Jonge, F. van Geer, H.P. Broers, and M. Bierkens, Utrecht Univ., The Netherlands.  
Environmental Science & Technology, Vol 44 No 4, p 1353-1359, 2010

The authors conducted a field-based testing, optimization, and evaluation study of the SorbiCell sampler (SC-sampler), a new passive sampling technique that measures average concentrations over longer periods of time (days to months) for various substances. The SC-sampler was tested within a catchment-scale monitoring study of NO<sub>3</sub> and P concentrations in surface water and tile drain effluent. The SC-samplers were capable of reproducing the NO<sub>3</sub> concentration levels and the seasonal patterns that were observed with weekly conventional grab sampling and continuous water quality measurements and results showed that average measurements produce more consistent load estimates than "snapshot" concentrations from grab sampling. When the purpose of a monitoring program is to estimate reliable (trends in) average concentrations or loads, the SC-samplers are a cost-effective alternative to grab sampling.

Application of a Permethrin Immunosorbent Assay Method to Residential Soil and Dust Samples  
Chuang, J.C., J.M. Van Emon, M.E. Tefft, and N.K. Wilson.  
Journal of Environmental Science and Health, Part B, Vol 45 No 6, p 516-523, 2010

A low-cost, high throughput bioanalytical screening method was developed for monitoring cis/trans-permethrin in dust and soil samples. The method consists of a simple sample preparation procedure [sonication with dichloromethane followed by a solvent exchange into methanol:water (1:1)] with bioanalytical detection using a magnetic particle enzyme-linked immunosorbent assay (ELISA). Quantitative recoveries (83 to 126%) of cis/trans-permethrin were obtained for spiked soil and dust samples. The percent difference of duplicate ELISA analyses was within +/- 20% for standards and +/- 35% for samples. Similar sample preparation procedures were used for the conventional GC/MS analysis except that additional cleanup steps were required. Recoveries of cis/trans-permethrin ranged from 81 to 108% for spiked soil and dust samples by GC/MS. The ELISA-derived permethrin concentrations were highly correlated with the GC/MS-derived sum of cis/trans-permethrin concentrations with a correlation coefficient (r) of 0.986. The ELISA method provided a rapid qualitative screen for cis/trans-permethrin in soil and dust while providing a higher sample throughput with a lower cost as compared to the GC/MS method. The ELISA can be applied as a low-cost screening tool to prioritize and rank samples prior to instrumental analysis for exposure studies.

## Application of Iron and Zinc Isotopes to Track the Sources and Mechanisms of Metal Loading in a Mountain Watershed

Borrok, D.M., R.B. Wanty, W.L. Ridley, P.J. Lamothe, B.A. Kimball, P.L. Verplank, and R.L. Runkel.

Applied Geochemistry, Vol 24 No 7, p 1270-1277, 2009

The hydrogeochemical constraints of a tracer dilution study were combined with Fe and Zn isotopic measurements to pinpoint metal loading sources and attenuation mechanisms in an alpine watershed affected by acid mine drainage. The inherent differences in the aqueous geochemistry of Fe and Zn provided complementary isotopic information. For example, variations in  $\delta^{56}\text{Fe}$  were linked to redox and precipitation reactions occurring in the stream, while changes in  $\delta^{66}\text{Zn}$  were indicative of conservative mixing of different Zn sources. Fen environments contributed distinctively light dissolved Fe and isotopically heavy suspended Fe precipitates to the watershed, while Zn from the fen was isotopically heavy. Acidic drainage from mine wastes contributed heavier dissolved Fe and lighter Zn isotopes relative to the fen. Upwelling of Fe-rich groundwater near the mouth of the catchment was the major source of Fe leaving the watershed in surface flow, while runoff from mining wastes was the major source of Zn. The results suggest that given a strong framework for interpretation, Fe and Zn isotopes are useful tools for identifying and tracking metal sources and attenuation mechanisms in mountain watersheds.

## Application of Optical Remote Sensing in the Petroleum and Petrochemical Industries

Modrak, M., W. Jozewicz, and G. Swett, ARCADIS, Research Triangle Park, NC.

IPEC 2009: 16th Annual International Petroleum & Biofuels Environmental Conference, 2-5 November, Albuquerque, New Mexico. 17 pp, 2009

Open-path optical remote sensing (ORS) is of particular interest for fence-line monitoring. ORS instruments use infrared, laser, or ultraviolet light to measure concentrations of chemical compounds of interest along the distance covered by the light signal. A light signal is sent out to mirrors deployed in the field, and the signal is reflected back to the instrument detector. Depending on the instrument and application, typical ORS instrument range varies from 50 to 500 meters. The major advantage of ORS instrumentation over traditional point monitors is their ability to provide an increased granularity of spatial information of the monitored area. The increased granularity reduces the chance of emissions hot spots being undetected over the measured area. It is possible to accomplish increased granularity because of the development of the radial plume mapping (RPM) method, which is capable of collecting concentration data along multiple beam paths in the configuration. In this method, multiple retro-reflecting mirrors are deployed in the survey area. RPM can be applied using any scanning ORS instrument. Depending on the mode, the ORS instrument can be scanning in a horizontal plane to deliver surface monitoring and to produce concentration contour maps. The ORS instrument can also be scanning in a vertical plane deployed downwind of the survey area to map the emissions plume downwind of the area of interest. By including meteorological data collected concurrently with the ORS measurements, the vertical RPM method can be used to calculate the downwind emission flux from the site. This paper presents various types of instruments that can be used for ORS measurements conducted at petroleum and petrochemical facilities. The basic principle of operation is described for each instrument with its operational capabilities, and performance comparisons of various types of instruments are made. Principles of and considerations for RPM

setup are discussed, OTM10 and TO16 methods are analyzed in the context of RPM, and actual industry experience is reviewed.

[http://ipec.utulsa.edu/Conf2009/Papers%20received/Swett\\_50.pdf](http://ipec.utulsa.edu/Conf2009/Papers%20received/Swett_50.pdf)

Application of Real-Time PCR, DGGE Fingerprinting, and Culture-Based Method to Evaluate the Effectiveness of Intrinsic Bioremediation on the Control of Petroleum-Hydrocarbon Plume  
Kao, C.M., C.S. Chen, F.Y. Tsa, K.H. Yang, C.C. Chien, S.H. Liang, C.A. Yang, and S.C. Chen.  
Journal of Hazardous Materials, Vol 178 Nos 1-3, p 409-416, 2010

Real-time polymerase chain reaction (PCR), denaturing gradient gel electrophoresis (DGGE), and the culture-based method were applied in an intrinsic bioremediation study at a petroleum-hydrocarbon contaminated site. The genes of phenol hydroxylase (PHE), ring-hydroxylating toluene monooxygenase (RMO), naphthalene dioxygenase (NAH), toluene monooxygenase (TOL), toluene dioxygenase (TOD), and biphenyl dioxygenase (BPH4) were quantified by real-time PCR. Results show that PHE gene was detected in groundwater contaminated with BTEX and MTBE, and this indicates that intrinsic bioremediation occurred at this contaminated site. Results from DGGE analyses reveal that the petroleum-hydrocarbon plume caused the variation in microbial communities. In this study, MTBE degraders including *Pseudomonas* sp. NKNU01, *Bacillus* sp. NKNU01, *Klebsiella* sp. NKNU01, *Enterobacter* sp. NKNU01, and *Enterobacter* sp. NKNU02 were isolated from the contaminated groundwater using the cultured-based method. Results from the MTBE biodegradation experiment show that the isolated bacteria were affected by propane, which indicates that propane can influence the metabolic pathway of MTBE by these bacteria.

Application of the Membrane Interphase [sic Interface] Probe (MIP): An Evaluation  
Bronders, J., I. Van Keer, K. Touchant, G. Vanermen, and D. Wilczek, Flemish Inst. for Technological Research (VITO), Belgium.

Journal of Soils and Sediments, Vol 9 No 1, p 74-82, 2009

A need exists for a better understanding of the sensitivity of the membrane interface probe (MIP(tm)) from Geoprobe Systems(r) for the characterization of soil contaminated with VOCs. Experience shows that misinterpretation of the collected data is common, mainly due to the lack of understanding and knowledge related to the detectors used, their detection limits, and the sensitivity of the MIP system. Lab tests (using solutions) and field measurements were carried out using different detector configurations to allow a better interpretation of the detector signals/system sensitivity and to collect qualitative information. These configurations were (1) detectors alone, (2) in a 2-ml sample loop, and (3) in a purge-and-trap system. Configurations 2 and 3 were used in combination with a capillary column to carry out on-site qualitative and semi-quantitative analyses. For the configuration of "stand-alone detectors," detection limits for toluene (in aqueous solutions) ranged between 4 ppm (flame ionization detector, or FID) and 10 ppm (photo-ionization detector, or PID). For chlorinated aliphatic hydrocarbons (CAHs), observed limits were 10 ppm (FID), 4 to 50 ppm (PID), and 3 to 10 ppm (dry electrolytic conductivity detector). When using the 2-ml sample loop, relatively high concentrations had to be present initially in the soil. Observed detection limits were 5 to 100 ppm for monoaromatic hydrocarbons, 1 to 50 ppm for CAHs, 250 to 400 ppm for alkanes, and 25 ppm for MTBE. The application of purge and trap resulted in a better resolution and the detection of lower

concentrations. Consequently, a better identification of the pollution with depth is possible. In this case, the detection limits were a function of the concentrations and the flushing time. In the qualitative analyses, the configuration of the MIP-system with the built-in capillary column and the 2-ml sample loop or the purge and trap preconcentrator, respectively, were useful for on-site analyses, thus allowing a better identification of the pollution in a vertical profile. The measurements carried out using the MIP alone or in combination with a loop or trap, or connected to a column, confirm that analysis is indeed very useful to characterize VOC source zones when knowing and understanding the detection limits of the MIP system. A 13-slide presentation illustrates the study. [http://www.ufz.de/data/VanKeerIlse\\_MIP\\_2009051410689.pdf](http://www.ufz.de/data/VanKeerIlse_MIP_2009051410689.pdf)

#### Application of Portable X-Ray Fluorescence (pXRF) for Heavy Metal Analysis of Soils in Crop Fields near Abandoned Mine Sites

Jang, M., Inst. of Mine Reclamation Technology, Seoul, Republic of Korea.  
Environmental Geochemistry and Health, Vol 32 No 3, p 207-216, 2010

A sampling method was verified for obtaining representative soil samples in crop fields near abandoned mines. Each crop field was sampled twice to verify the reproducibility of a zigzag method for soil sampling. Analytical results using a pXRF device to measure concentrations of metal species in soils were compared to the concentrations extracted by the Korean Standard Test (KST) for soil. As a result, the determination coefficient ( $R(2)$ ) of linear regression analysis for data obtained by ex situ precise measurement and in situ field screening using pXRF was closely related with the ratio of the extracted concentration by KST to interference-free detection limits (IFDL) of pXRF (designated as KST/IFDL). As the specific metal species had a higher ratio of KST/IFDL, its  $R(2)$  was higher in the field screening tests. The slopes of linear regression analysis for most metal species extracted by aqua-regia were close to 1.0 so that extracted concentrations by aqua-regia were similar to the analytical values obtained by pXRF, whereas extraction using a weak acid (0.1 M HCl) had different slopes for soil contaminated with different ranges of concentrations of metal species. Zn in particular showed not only high ratios of KST/IFDL via aqua regia extraction, but also high determination coefficients. Owing to its simple, rapid, and accurate capacities for metal analysis, pXRF analysis showed high applicability in both ex situ precise measurements and metals screening in the field. Field screening with the zigzag method can be applied to achieve an economical survey for determining hot spots or non-contaminated areas if aqua-regia is applied as the extracting agent in the KST for soil.

#### Application of Small-Spot Energy Dispersive X-Ray Fluorescence Instrumentation in Phytoremediation Activities Around Metal Mines

Margui, E., A. Jurado, M. Hidalgo, G. Pardini, M. Gispert, and L. Queralt.  
Applied Spectroscopy, Vol 63 No 12, p 1396-1402, Dec 2009

Researchers evaluated the potential of a low-cost benchtop energy dispersive X-ray fluorescence (EDXRF) instrument for contaminant analysis while studying the potential use of sunflowers (*Helianthus annuus*) for the phytoremediation of an abandoned Pb/Zn mining area. The unit's simplicity and ability to operate at ambient temperature in open-air conditions provided a flexible setup for rapid analysis of vegetation without sample pretreatment. The use of different collimator caps achieved a modest lateral resolution (from 200  $\mu\text{m}$  to 1 mm), which

was thought to be small enough to study the accumulation and distribution of Pb and Zn in the plant specimens (roots, stems, and leaves). The limits of detection achieved (0.6 ng for Zn and 3.0 ng for Pb) proved to be suitable for the intended purpose. The results obtained indicate that EDXRF spectrometry could be a useful tool for evaluating metals uptake, translocation, and tolerance mechanisms in vegetative species used in biomonitoring and phytoremediation studies.

#### Applying Geochip Analysis to Disparate Microbial Communities

Zhou, J., Z. He, J.D. Van Nostrand, L. Wu, and Y. Deng, Univ. of Oklahoma, Norman. Microbe Magazine, Vol 5 No 2, Feb 2010

GeoChip is a powerful, high-throughput metagenomic tool for analyzing microbial communities, including their structure, metabolic potential, diversity, and impact on ecosystem functions. In 2009, GeoChip received an R&D100 Award from R&D Magazine, which recognizes the 100 most innovative scientific and technical breakthroughs of the year. Recent developments have improved GeoChip in terms of specificity, sensitivity, probe design, computer program development, and target amplification of DNA and RNA molecules. These developments are making it possible to use functional gene arrays to analyze environmental samples, despite bottlenecks in processing and interpreting hybridization data. Novel mathematical and bioinformation tools are urgently needed to speed data processing, data mining, and visualization. As a tool, GeoChip should be integrated with studies focused on clear and addressable ecological and environmental questions and hypotheses. A new era of quantitative predictive microbial ecology is coming. Additional information and contacts for this technology are available on the University of Oklahoma's Institute for Environmental Genomics Web site at <http://ieg.ou.edu/>.

#### Assessment of Advective Porewater Movement Affecting Mass Transfer of Hydrophobic Organic Contaminants in Marine Intertidal Sediment

Cho, Y.M., D. Werner, K.B. Moffett, and R.G. Luthy.

Environmental Science & Technology, 2010 [epub ahead of printing]

Porewater movement was assessed in an intertidal mudflat in South Basin adjacent to Hunters Point Shipyard, San Francisco, CA, where a pilot-scale test of sorbent amendment was being conducted for the in situ stabilization of PCBs. To quantify advective porewater movement within the top 0- to 60-cm sediment layer, temperature was used as a tracer, and heat transport analysis was conducted using 14-day data from multidepth sediment temperature logging stations and 1-D heat transport simulations. The best-fit conditions gave an average Darcy velocity of 3.8 cm/d in the downward vertical direction for sorbent-amended sediment with a plausible range of 0 cm/d to 8 cm/d. In a limiting case with no net advection, the best-fit depth-averaged mechanical dispersion coefficient was  $2.2 \times 10^{-7} \text{m}^2/\text{s}$  with a range of  $0.9 \times 10^{-7} \text{m}^2/\text{s}$  to  $5.6 \times 10^{-7} \text{m}^2/\text{s}$ . The Peclet number for PCB mobilization showed that molecular diffusion would control PCB mass transfer from sediment to sorbent particles for the case of uniform distribution of sorbent; however, the advective flow and mechanical dispersion in the test site would benefit the stabilization effect of heterogeneously distributed sorbent significantly by acting to smooth out the heterogeneities and homogenizing pollutant concentrations across the entire bioactive zone. These measurements and modeling techniques on intertidal sediment porewater transport could be useful for the development of more reliable mass transfer models

for predicting contaminant release within the sediment bed, the movement of hydrophobic organic compounds in the intertidal aquatic environment, and in situ sequestration by sorbent addition.

#### Assessment of MTBE Biodegradation Pathways by Two-Dimensional Isotope Analysis in Mixed Bacterial Consortia under Different Redox Conditions

Youngster, L.K., M. Rosell, H.H. Richnow, and M.M. Haegglblom.

Applied Microbiology and Biotechnology, 2010 Jun 27. [Epub ahead of print]

Multidimensional compound-specific isotope analysis (CSIA) of carbon and hydrogen is being developed for determining the extent of MTBE loss due to biodegradation and potentially can be used to distinguish between different biodegradation pathways. Carbon and hydrogen isotopic fractionation factors were determined for MTBE degradation in aerobic and anaerobic laboratory cultures. The carbon isotopic enrichment factor ( $\epsilon_C$ ) for aerobic MTBE degradation by a bacterial consortium containing the aerobic MTBE-degrading bacterium, *Variovorax paradoxus*, was  $-1.1 \pm 0.2$  per thousand and the hydrogen isotope enrichment factor ( $\epsilon_H$ ) was  $-15 \pm 2$  per thousand. The stable-isotope enrichment factors determined in this study will enhance the use of CSIA for monitoring anaerobic and aerobic MTBE biodegradation in situ.

#### Bacteria Now Capable of Shedding Light on Landmine Locations

Davey, K.

EUSci: Edinburgh University Science Magazine, 23 Nov 2009

Custom made bacteria have been designed to light up green when they come into contact with landmines. This work, produced by students at the university, gives hope for a cheap and effective method of detecting landmines in countries such as Somalia, Mozambique, Cambodia, Iraq, and Afghanistan where landmines pose a considerable risk to the public. The bacteria have been created using a novel technique known as BioBricking, where individual parts--BioBricks--are selected to create a molecule. When the bacteria come into contact with leaked chemical vapors from the explosives, a reaction takes place that changes their previously colourless solution into a fluorescent green. Because of their custom design, the bacteria pose no threat to people or animals, and can be sprayed from the air over large areas where the presence of landmines is suspected. Although there are no plans yet to commercialize the product, it is hoped to one day provide a widely accessible alternative to traditional explosive sensing methods.

#### Bioremediation of Heavy Hydrocarbons: Reducing Uncertainty in Meeting Risk-Based Targets: Laboratory to Field Scale (Promise Project)

CL:AIRE (Contaminated Land: Applications in Real Environments), RB-10, 8 pp, Jan 2010

This bulletin describes weathered hydrocarbon transformation and its implications for bioremediation, analysis, and risk assessment. A novel solvent ultrasonic extraction procedure for soils contaminated with weathered hydrocarbons is presented, allowing petroleum hydrocarbon class fractionation and identification of risk-indicator compounds. This method has been developed by and through the company, TES Bretby, and is a competitive

market technique. The method covers the determination of total petroleum hydrocarbons (TPH) between nC8 and nC40 and sub-ranges of hydrocarbons in support of the UK regulatory framework. Further modifications to the carbon banding can be made as requested for risk-assessment, including ranges known as Texas banding, as well as separation of the aliphatic and aromatic fractions. The method can be used routinely for measuring hydrocarbons down to 10 mg/kg in soil. The method ISO17025 has been accredited for TPH analysis, banding, and class separation. A Web site dedicated to the project has been designed. The site will post research outcomes and advertise new events on contaminated land related issues. The Web site is accessible at <http://www.cranfield.ac.uk/sas/resource/research/promise/index.jsp>.

#### Biosensing for the Environment and Defence: Aqueous Uranyl Detection Using Bacterial Surface Layer Proteins

Conroy, D.J.R., P.A. Millner, D.I. Stewart, and K. Pollmann.  
Sensors, Vol 10 No 5, p 4739-4755, 2010

At cleanup sites where a complete remediation strategy is not possible, the application of biosensing technologies is a practical solution for continuous monitoring of target metal ions. This paper reports the fabrication of novel uranyl (UO<sub>2</sub>(2+)) binding protein-based sensors. The new biosensor responds to picomolar levels of aqueous uranyl ions within minutes using *Lysinibacillus sphaericus* JG-A12 surface layer protein (SLP) tethered to gold electrodes. In comparison to traditional self-assembled monolayer based biosensors, the porous bioconjugated layer gives greater stability, longer electrode life span, and a denser protein layer. Biosensors responded specifically to UO<sub>2</sub>(2+) ions and showed minor interference from Ni<sup>2+</sup>, Cs<sup>+</sup>, Cd<sup>2+</sup>, and Co<sup>2+</sup>. Chemical modification of JG-A12 protein phosphate and carboxyl groups prevented UO<sub>2</sub>(2+) binding, showing that both moieties are involved in the recognition to UO<sub>2</sub>(2+). This approach provides a new means of fabricating metal ion biosensors, and it is possible that SLP isolates from bacteria surviving in other metal-contaminated sites might provide the sensing components for fabrication of other metal ion biosensors.

<http://www.mdpi.com/1424-8220/10/5/4739/pdf>

#### Carbon Composite Electrodes Applied for Electrochemical Sensors

Manea, F., C. Radovan, A. Pop, I. Corb, G. Burtica, P. Malchev, S. Picken, and J. Schoonman.  
Sensors for Environment, Health and Security: Advanced Materials and Technologies  
Springer, Dordrecht. ISBN: 978-1-4020-9010-3, p 179-189, 2009

Electrodes based on particulate carbon-epoxy or polystyrene composites have been formed and characterized using electrochemical methods. Working electrodes made of various forms of graphite or carbon and using different polymers--a type of expanded and exfoliated graphite-epoxy (EEG-Epoxy), carbon nanofiber-expanded graphite-epoxy (CNF-EG-Epoxy), expanded graphite-polystyrene (EG-PS), expanded graphite-epoxy (EG-Epoxy)--were tested for electrochemical sensing of various organic pollutants in aqueous solution. The prepared carbon composite electrodes showed good mechanical strength, low electrical resistance, and easy new surface by simple polishing, all useful characteristics for electroanalytical purposes.

## Carbon Nanostructure-Based Field-Effect Transistors for Label-Free Chemical/Biological Sensors

Hu, P.-A., J. Zhang, L. Li, Z. Wang, W. O'Neill, and P. Estrela.  
Sensors, Vol 10 No 5, p 5133-5159, 2010

Owing to their particular structure, excellent electrical properties, and high chemical stability, carbon nanotube- and graphene-based electrical devices have been widely developed for high-performance label-free chemical/biological sensors. The latest developments are reviewed of carbon nanostructure-based transistor sensors in ultrasensitive detection of chemical/biological entities, such as poisonous gases, nucleic acids, proteins, and cells.  
<http://www.mdpi.com/1424-8220/10/5/5133/pdf>

## Challenges with the Analysis of 1,4-Dioxane

Neslund, C.J., Lancaster Laboratories, Inc., Lancaster, PA.

EMDQ 2010: DoD Environmental Monitoring and Data Quality Workshop, 12-16 April 2010, Louisville, Kentucky. 22 presentation slides, 2010

Until recently, 1,4-dioxane has received little attention from regulating authorities. The use of 1,4-dioxane as a solvent stabilizer for solvents such as trichloroethane (TCA) has caused the reevaluation of previously closed TCA sites. Although 1,4-dioxane is listed as a volatile compound under SW-846 Method 8260, the performance of 1,4-dioxane under standard 8260 conditions often cannot meet site-specific data quality objectives. The response has been to modify SW-846 methods 8260 and 8270 to meet or exceed a health-based advisory level of 3 ug/L. This presentation discusses the details of these analytical method modifications and the advantages and pitfalls of each.

<https://www.regonline.com/custImages/240809/Technical%20Presentations/2%20-%20Neslund.pdf>

## Common Criteria Related Security Design Patterns: Validation on the Intelligent Sensor Example Designed for Mine Environment

Bialas, A.

Sensors, Vol 10 No 5, p 4456-4496, 2010

Intelligent sensors are able to measure and process data and communicate with other information technology (IT) devices or systems. Such sensors are often used in high risk applications. To improve their robustness, these sensor systems should be developed in a restricted way to provide them with assurance. Common Criteria (ISO/IEC 15408) can be used for assurance in IT products and systems. A concise Common Criteria-compliant and pattern-based method for intelligent sensors security development is presented. The sensor was evaluated for detecting methane in a mine environment, focusing on intelligent sensor definition and solution. <http://www.mdpi.com/1424-8220/10/5/4456/pdf>

## Comparing Means and Confidence Intervals of Discrete, Composite, and IS Environmental Study Data

Tomljanovic, C., CTC.

E2S2 2010: Environment, Energy Security, and Sustainability Symposium and Exhibition, 14-17 June 2010, Denver, Colorado. National Defense Industrial Association (NDIA), Abstract 9762, 72 presentation slides, 2010

Incremental sampling (IS) was developed as a more effective and cost-efficient tool for site characterization activities that include vast tracts of land, such as is typical of DoD facilities. IS considers the surface soil of a chosen area (decision unit) as a whole sample, rather than several individual samples, to determine the average concentration level of contaminants. The demonstration and validation of IS as a useful site characterization tool, compared to the previously used methods of discrete or limited composite sampling, has included careful DoD site selection, collection of samples and replicates, reviewing and discussing field sampling techniques, and examining the results of extraction and analysis using U.S. EPA method 8330B. This presentation addresses the development of exposure point concentrations (EPCs) with IS data collected from a 2009 DoD study, comparing the means and upper confidence intervals of available discrete, composite, and IS environmental study data to explore the benefits of IS approaches in environmental risk assessment in comparison to environmental data collected via traditional methods. <http://e2s2.ndia.org/schedule/Documents/Abstracts/9762.pdf>

## Comparison of Analyzing and Quantifying Total PCBs by Different Methods at the New Bedford Harbor Superfund Site OU#3 Site

Koenig, M.R., E. Stanley, and B. Leitch.

EMDQ 2010: DoD Environmental Monitoring and Data Quality Workshop, 12-16 April 2010, Louisville, Kentucky. 37 slides, 2010

The New Bedford Harbor Superfund site located in southeastern Buzzards Bay region of Massachusetts has been identified as one of the world's marine estuaries most highly contaminated with PCBs. The overall site covers nearly 18,000 acres of Upper (187 acres) and Lower (750 acres) New Bedford Harbor, and adjacent areas of Buzzards Bay (17,000 acres). To date, ~340,000 cubic yards of contaminated sediment have been removed from the harbor. The outer harbor area, termed Operable Unit #3 (OU#3), is the area where recent remedial investigation/feasibility study (RI/FS) samples were collected for PCB analysis. Several different methods of analyzing and quantifying total PCBs have been debated. Different methods of analyzing and quantifying total PCBs were performed and evaluated at the NBH OU#3 site. Because the primary data users of the RI/FS had different data needs and requirements, analytical and quantitation methods that satisfied all criteria were chosen. EPA Method 8270C-GC/MS-SIM, modified for the analysis of the 209 PCB congeners, was performed as the primary analytical method. This method alone supported several end user needs. Historical long-term monitoring of the 18 NOAA congener trends, Massachusetts Division of Marine Fisheries Monitoring of edible seafood using 134 PCB congeners, human and ecological risk assessments including EPA/WHO dioxin-like PCB congeners, and total PCB quantitation by summation of the 209 PCB congeners were all obtained using this method. Alpha Analytical of Mansfield, Massachusetts, performed the 8270C-GC/MS-SIM method and also offered to perform PCB analysis by Method 8082-GC/ECD for Aroclors, as well as Method 8270C-GC/MS-SIM for PCB Homologues. Selected sediment and tissue samples from the NBH OU#3 RI/FS were

compared by these different analysis and quantitation methods for reporting total PCBs. The presentation compares the total PCB results and discusses the analytical methodologies in detail. The pros and cons of these comparison findings were evaluated based on the analytical methodologies, the project-specific measurement performance criteria, and data quality objectives. <https://www.regonline.com/custImages/240809/Technical%20Presentations/3%20-%20Koenig%20Comparison%20of%20Different%20Methods%20of%20Quantifying%20Total%20PCBs%20at%20.pdf>

#### Comparison of Multiple Bioassays to High-Resolution Gas Chromatography for Quantification of Polychlorinated Biphenyls and Dioxins/Furans in Sediment

Michalsen, M., J. Wakeman, K. Takasaki, and L. Inouye.

E2S2 2010: Environment, Energy Security, and Sustainability Symposium and Exhibition, 14-17 June 2010, Denver, Colorado. National Defense Industrial Association (NDIA), Abstract 10154, 19 presentation slides, 2010

U.S. EPA has published several assay methods for quantifying Toxicity Equivalent (TEQ) concentrations of 2,3,7,8-substituted polychlorodibenzo-dioxins and polychlorodibenzofurans. Such assays cost less than half of Method 1613b (HRGC/MS) dioxin analysis but have not been evaluated against HRGC/MS at low concentrations relevant to Puget Sound regional sediment management goals. In this study, 91 Puget Sound sediment samples were analyzed by HRGC/MS and three assays: CALUX, 101L, and Procept. Assay performance was evaluated against HRGC/MS results using regression, relative percent differences (RPDs), and false positive/false negative error rates when compared to interim dredge material sediment screening values (4 and 10 ng/kg 2,3,7,8-tetrachloro-p-dibenzodioxin equivalents or TEQ) for Puget Sound. CALUX results were significantly correlated with HRGC/MS, but 101L and Procept results were not. Procept was performed using modified methods and was not carried through full evaluation. Both CALUX and 101L had false negative rates equal to or less than 10%; CALUX had very low false positive rates, and 101L had substantially higher rates. Both assays appeared to give more reliable decisions at the 10 ng/kg TEQ screening level. RPDs indicated that sampling error might have contributed significantly to total measurement error in this study. Sediment management decisions could be improved by increasing replication, which could be more cost feasible with these less costly assays.

<http://e2s2.ndia.org/schedule/Documents/Abstracts/10154.pdf>

#### Compound Specific Isotope Analysis

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools Web site, 27 pp, Jan 2010

When managing contaminated sites, it is important to understand the source of the contamination as well as the fate and transport of the contaminant. Specifically, all potential degradation pathways should be evaluated at the site. If the contaminant is being degraded, understanding the mechanism by which it is being degraded aids in making site management decisions for monitoring natural attenuation and active remedies at the site. The main method by which contaminant degradation has been monitored is by measuring contaminant concentrations over time, but this approach has led to some uncertainty as to whether or not contaminants are being degraded, simply diluted by the groundwater, or adsorbed by the soil matrix. Compound-

specific isotope analysis (CSIA) is a novel approach that provides information on whether the contaminant is being degraded and also the reaction mechanism. It works by tracking the change in the ratio of isotopes in the organic contaminant as degradation takes place. This paper presents an overview of the uses and applications of CSIA. It provides information on collecting samples for CSIA and interpreting data, and it also presents case studies where CSIA has been used for various applications at contaminated sites.

<http://www.ert2.org/CSIA/tool.aspx>

Constantly Stirred Sorbent and Continuous Flow Integrative Sampler: New Integrative Samplers for the Time Weighted Average Water Monitoring

Llorca, J., C. Gutiérrez, E. Capilla, R. Tortajada, L. Sanjuán, A. Fuentes, and I. Valor.

Journal of Chromatography A, Vol 1216 No 3, p 5783-5792, 2009

Two innovative integrative samplers have been developed that enable high sampling rates unaffected by turbulence (thus avoiding the use of performance reference compounds) and with negligible lag time values. The constantly stirred sorbent (CSS) sampler consists of a rotator head that holds the sorbent. The rotation speed given to the head generates a constant turbulence around the sorbent, making it independent of external hydrodynamics. The continuous flow integrative sampler (CFIS) consists of a small peristaltic pump that produces a constant flow through a sorbent-containing glass cell. Although different sorbents can be used, poly(dimethylsiloxane) PDMS under the commercial twister format (typically used for stir bar sorptive extraction) was evaluated for the sampling of 6 PAHs and three organochlorine pesticides. These new devices are similar to passive samplers, but they need a small energy supply of around 0.5 W supplied by a battery. Sampling rates from  $181 \times 10^{-3}$  to  $791 \times 10^{-3}$  L/day were obtained with CSS and  $18 \times 10^{-3}$  to  $53 \times 10^{-3}$  with CFIS. Limits of detection for these devices are in the range from 0.3 to 544 pg/L with a precision below 20%. A field evaluation of both devices was carried out in a 5-day sampling study at the outlet of a wastewater treatment plant, with results comparable to those obtained with a classical sampling method.

Contaminants in Low Level Analyses: II. Hexavalent Chromium Analyses

Rubenstein, M. (USAF School of Aeronautical Medicine), C. Galarza, and D. McClain.

EMDQ 2010: DoD Environmental Monitoring and Data Quality Workshop, 12-16 April 2010, Louisville, Kentucky. 32 presentation slides, 2010

The U.S. Air Force Analytical Services Laboratory continues to work on lowering reporting limits for hexavalent chromium and now has a reporting limit (RL) of 0.030 ug/filter; however, at this RL, difficulties arise due to background interference at or above the RL. Similar interferences are being experienced at other service and commercial labs and have been ascribed anecdotally to the process involved in the manufacture of PVC filters. The low levels of interference observed as Cr(VI) has made identification difficult, and wide variance has been observed in the concentration of the interference. Research indicates that the interference arises from chromium present on PVC filters. Additional experimentation shows that the chromium can be removed by hydrogen peroxide. The same oxidation process quantitatively converted the chromium present to Cr(VI). A procedure is presented to remove chromium from the filters that produces chromate-free PVC filters.

<https://www.regonline.com/custImages/240809/Technical%20Presentations/1%20-%20Rubenstein.pdf>

Cyanide Analysis for Wastewater Compliance Testing: Laboratory Perspective  
Burrows, R., TestAmerica.

NEMC 2009: The 25th Annual National Environmental Monitoring Conference, 19 presentation slides, 2009

In most cases, the lab does not know if any sample constituents that might interfere with cyanide are in the sample. In some cases, the analytical method to be used is specified in the wastewater permit. The price for cyanide analysis is in the range of \$40. By far, the most requests received are for determination of total cyanide. This presentations discusses the methodology specified in Footnote 6 of 40 CFR Part 136.3, potential updates to this section, and procedures and problems encountered with ASTM D7365.

[http://www.nemc.us/nemc09\\_presents/Presentation-Cyanide-RichardBurrows-8-13-09.pdf](http://www.nemc.us/nemc09_presents/Presentation-Cyanide-RichardBurrows-8-13-09.pdf)

Deliverable 2.1.1: State of the Art on Chemical Sensors for Early Warning Systems

Monsorez, Albin.

SecureEAU Project No 217976, 34 pp, Dec 2009

This report describes currently available early warning systems for rapid detection of deliberate intrusion in drinking water networks. It is roughly a technology review of devices (including their principles of measurement) to monitor water quality. Only multi-parameter probes that have already been commercialized are considered in this review. Many devices are not fitted to drinking water network monitoring but rather are designed for environmental surveys (lake, oceanographic studies); however, the multiparameter probes described in this report offer several technologies suitable for monitoring the security of a drinking water network. The following technologies are evaluated: Hach - the In-Pipe Probe; Censar - Six Cense; Intellitect - Intellisonde; Silsens; YSI - Probe 600DW; Horiba – U-22XD; Eureka - MANTA Big4; Hydrolab - QUANTA G; Hydrolab - MS 5; Greenspan - CS304; and In-Situ Inc. - TROLL 9500. After a short description of other projects in this field, relevant water quality parameters are defined in Part I, and sanitary aspects and data treatment issues are introduced. The list of multi-parameter probes available on the market is given in Part II. A protocol to evaluate the probes previously selected and preliminary results on two of them are described Part III.

[http://www.secureau.eu/fileadmin/Secureau/Deliverables\\_PU/WP2\\_D211\\_SiteWEB.pdf](http://www.secureau.eu/fileadmin/Secureau/Deliverables_PU/WP2_D211_SiteWEB.pdf)

Demonstration/Validation of IS at Two Diverse Military Ranges and Development of an IS Tool  
Roote, D., CTC.

E2S2 2010: Environment, Energy Security, and Sustainability Symposium and Exhibition, 14-17 June 2010, Denver, Colorado. National Defense Industrial Association (NDIA), Abstract 10050, 46 presentation slides, 2010

Multi-increment sampling (MIS) was developed as a more effective and cost efficient soil characterization method for DoD ranges compared to traditional sampling methods. MIS consists of random systematic collection of typically 30 to 100 small soil increments within a decision unit and combining them into one sample. The entire 1 to 2 kg sample is processed in the laboratory so that the results represent the average concentration level of contaminants within the decision unit. For this demonstration and validation (dem/val) project, MIS in conjunction with U.S. EPA Method 8330B was compared to the previously used methods of discrete and limited increment composite sampling with analysis by U.S. EPA Method 8330A. An incremental

sampling (IS) tool was developed and tested in conjunction with this project. This tool is now available commercially as the "EVC IS Soil Stick" and is suitable for shallow surface soil sampling. Soil sampling was conducted at two diverse DoD ranges in 2009, one for TNT in the arid Southwest, near Holloman AFB, NM, and the other for nitroglycerin in the Pacific Northwest at Fort Lewis, WA. Soil, climate, and contaminant conditions varied greatly at the two sites. At both sites, it was determined that the in-lab MIS subsampling method that is an integral part of EPA 8330B provides a better subsample than does the scoop-off-the-top subsampling method used in EPA 8330A. MIS field replicates showed less variation than those collected using the traditional (discrete, box, and wheel) discrete and composite soil sampling methods at both sites and therefore was judged to be a superior method to estimate the mean concentration of the energetic constituents concentrations within a given decision unit. Comparison of the EPA 8330B detection methods showed less variability in replicates with the UV as compared to the MS detection method, but both were acceptable. Although UV costs less, there could be project-related considerations where MS would be preferred. A cost-benefit analysis conducted to compare MIS with the traditional soil sampling methods used for DoD ranges showed that MIS is more cost-effective than discrete or traditional composite sampling methods for collection of equivalent quality data. <http://e2s2.ndia.org/schedule/Documents/Abstracts/10050.pdf>

#### Demonstration/Validation of Long-Term Monitoring Using Wells Installed by Direct Push Technologies and Enhanced Low-Flow Groundwater Sampling Methods

Major, W., T. McHale, M. Kram, L. Parker, and J. Michelsen.

Environmental Security Technology Certification Program (ESTCP), Project ER-0011, TM-2410-ENV, 317 pp, Oct 2009

A multi-site long-term monitoring (LTM) project has been conducted to determine whether there is significant statistical difference between groundwater monitoring results obtained from direct-push and conventional hollow-stem auger-installed wells. The five field sites in the study represent a variety of geologic conditions as well as a cross-section of regulatory domains (e.g., EPA regions and states). Direct-push wells in well pairs or clusters have been installed adjacent to existing hollow-stem auger-drilled wells at facilities in Hanover, New Hampshire, Dover AFB, Delaware, Port Hueneme, California, Tyndall AFB, Florida, and Hanscom AFB, Massachusetts. Over a 5-year period (Phase I and II), 13 sampling events have been completed at the sites in which groundwater samples have been analyzed for parameters typically examined with long-term site compliance monitoring including chemical concentrations, oxidation-reduction potential, pH, temperature, conductivity, turbidity, and dissolved oxygen. The target analytes for this project include PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, vinyl chloride, the BTEX compounds, 1,4-dichlorobenzene (DCB), trichloroethane, and MTBE. Analysis with variance statistical methods have been employed to address a wide range of inherent variables, such as well depth, screen length, filter packs, annular sealing, spatial and temporal heterogeneity, groundwater seasonal changes, plume characteristics, and geological conditions. Inorganic data also were collected on an annual basis to assess the performance of the direct-push well for monitoring natural attenuation at the five test sites. Additionally, the ESTCP LTM project team partnered with ITRC to product a Direct-Push Well Technology Technical/Regulatory Guidance Document and Internet training module.

<http://www.estcp.org/Technology/upload/ER-0011-FR.pdf>

See also the Cost and Performance Report (2008): <http://www.estcp.org/Technology/upload/ER-0011-C&P.pdf>

#### Design of a Portable, Battery Powered Quadrupole Mass Spectrometer System for Real-Time Sampling of Materials

Dillingham, T.R., T.L. Porter, and D.M. Cornelison (Northern Arizona Univ., Flagstaff); R.J. Venedam (National Security Technologies LLC, Las Vegas, NV).

Symposium Q: Materials Science of Water Purification, 14-16 April 2009. Materials Research Society, Warrendale, PA. MRS Symposium Proceedings Vol 1169E, paper Q6.10, 2009

The authors have designed and constructed a low-cost, portable, battery-powered quadrupole mass spectrometer for use in the materials analysis of gaseous, liquid, or solid field samples. The system can be configured for continuous sampling of ambient gas samples or for the analysis of small solid, liquid or gas samples in sealed glass vials. The system is capable of measuring partial pressures down to the  $10^{-10}$  Torr range, and can be operated on battery power for several hours in a field deployment. Information is presented on the specific design parameters and on the testing of the instrument. Preliminary results are reported for solid dinitrotoluene (DNT) and for chlorinated hydrocarbons and other contaminants in water.

#### Detection and Characterization of Chemical Vapor Fugitive Emissions by Nonlinear Optimal Estimation: Theory and Simulation

Gittins, C.M.

Applied Optics, Vol 48, p 4545-4561, 2009

This paper addresses detection and characterization of chemical vapor fugitive emissions in a nonscattering atmosphere by processing of remotely-sensed long-wavelength infrared spectra. The analysis approach integrates a parameterized signal model based on the radiative transfer equation with a statistical model for the infrared background. The maximum likelihood model parameter values are defined as those that maximize a Bayesian posterior probability and are estimated using a Gauss-Newton algorithm. For algorithm performance evaluation we simulate observation of fugitive emissions by augmenting plume-free measured spectra with synthetic plume signatures. As plumes become optically thick, the Gauss-Newton algorithm yields significantly more accurate estimates of chemical vapor column density and significantly more favorable plume detection statistics than clutter-matched-filter-based and adaptive-subspace-detector-based plume characterization and detection.

#### Detection and Characterization of Chemical Vapor Fugitive Emissions from Hyperspectral Infrared Imagery by Nonlinear Optimal Estimation

Gittins, C.M.

Proceedings of SPIE--The International Society for Optical Engineering, Volume 7695, 2010

The clutter-matched filter (CMF) and the Adaptive Cosine Estimator (ACE) have become established metrics for detecting chemical vapor plumes from hyperspectral infrared imagery. Both metrics follow from the presumption of a linear additive signal model; however, examination of the underlying radiative transfer equation (RTE) indicates that while the use of a linear additive signal model is a reasonable approximation when considering an optically thin

plume viewed against blackbody background the RTE is in fact nonlinear. Unfortunately, presumption of a linear additive signal model can degrade plume detection statistics significantly and result in significant errors in estimated chemical vapor column density when plumes are not optically thin or are viewed against spectrally complex backgrounds. This paper describes a nonlinear estimation approach that integrates a parameterized signal model based on the RTE with a statistical model for the infrared background. Results obtained by applying the nonlinear estimation approach to background-only hyperspectral imagery augmented with synthetic chemical vapor plumes were compared with results obtained presuming a linear additive signal model. As plumes become optically thick, nonlinear estimation yields significantly more accurate estimates of chemical vapor column density and significantly more favorable plume detection statistics than clutter-matched-filter-based and adaptive-subspace-detector-based plume characterization and detection. <http://handle.dtic.mil/100.2/ADA522526>

#### Determination of Arsenic(III) Using Platinum Nanoparticle-Modified Screen-Printed Carbon-Based Electrodes

Sanllorenzo-Mendez, S., O. Domínguez-Renedo, and M.J. Arcos-Martínez.  
Electroanalysis, Vol 21 Nos 3-5, p 635-639, 2009

The electrochemical detection of arsenic(III) was investigated on platinum nanoparticle-modified carbon-based screen-printed electrodes (PtNPs/SPCEs) in 1 M aqueous H<sub>2</sub>SO<sub>4</sub>. PtNPs/SPCEs were prepared by electrochemical deposition of K<sub>2</sub>PtCl<sub>6</sub>. The resulting electrode surfaces were characterized with scanning electron microscopy (SEM). By using the As(III) oxidation peak for the analytical determination, there is no interference from Cu(II) if present in contrast to the other metal surfaces typically used for the detection of arsenic in electrochemistry. Precision of the proposed method was very good and a relative good accuracy was determined by analysis of a certificate sample and a spiked tap water sample. Electroinactive As(V) was reduced to As(III) by sodium thiosulfate prior to determination. The detection limit for As(III) obtained was 5.68 g/L. In terms of reproducibility, the precision of the above mentioned method in % RSD was calculated at 2.27%.

#### Determination of Pyrethroid Insecticides in Sediment by Gas Chromatography-Ion Trap Tandem Mass Spectrometry

You, J., D. Wang, and M.J. Lydy.  
Talanta, Vol 81 Nos 1-2, p 136-141, Apr 2010

A method was developed to analyze 10 pyrethroid insecticides in sediment by GC-MS/MS after accelerated solvent extraction and solid-phase extraction cleanup. The MS/MS parameters included selection of the precursor and product ions, excitation mode, excitation amplitude, and the stability parameter qz, and were optimized to maximize detection sensitivity. Due to its superior ability to remove background noise, GC-MS/MS showed elevated selectivity and improved confidence in peak identification compared to GC-electron capture detector (ECD). The instrumental detection limits for GC-MS/MS ranged from 148 to 4033 fg, and the calibration curves were linear from 5 to 1,000 ug/L for all of the pyrethroids except cyfluthrin. The method detection limits for pyrethroids ranged from 0.10 to 0.80 ug/kg dry sediment, while the recoveries were 59.7 to 128%, 60.6 to 90.9%, and 63.2 to 83.6%, with the relative standard deviations of 5.3 to 25.3%, 1.1 to 10.6%, and 3.0 to 15.6% at the spiking levels of 1, 5, and 20

ug/kg, respectively. Field sediment collected from California was used to validate the newly developed method, and analytical results were comparable to those by GC-ECD in most cases, although as a result of the cleaner background, more pyrethroids were identified by GC-MS/MS.

#### Development and Application of Dynamic Air Chambers for Measurement of Volatilization Fluxes of Benzene and MTBE from Constructed Wetlands Planted With Common Reed

Reiche, N., W. Lorenz, and H. Borsdorf.

Chemosphere, Vol 79 No 2, p 162-168, Mar 2010

In a horizontal-flow constructed wetland planted with reed grass, volatilization of VOCs was quantified using a specially designed air chamber for routine sampling over the course of one year. Results indicate that the overall volatilization of the observed benzene and MTBE depended on seasonal variations, with the highest volatilization fluxes measured in summer, when the detected volatilization fluxes of 846 +/- 116 and 252 +/- 11 ug/m(2)/h for MTBE and benzene, respectively, accounted for 2.4% and 5.6% of the respective overall contaminant mass loss in the planted wetland. The chamber data derived from this phytoremediation study give strong evidence for the increased volatilization of VOCs through vegetation by direct comparison of planted and unplanted wetlands.

#### The Development and Applications of Molecular Techniques for BTEX Treatment

Jang, Yuh-Chuahn, Feng-Yue Weng, Yan-Lin Huang, and Jung-Tze Chen, Development Center for Biotechnology, Xizhi City, Taiwan, R.O.C.

IPEC 2009: 16th Annual International Petroleum & Biofuels Environmental Conference, 2-5 November, Albuquerque, New Mexico. Abstract only, 2009

Benzene and toluene were discovered in the subsurface at a petroleum plant located in Southern Taiwan. A pilot study was initiated to evaluate the effect of molecular techniques, including DNA analysis and a reporter gene system, on bioremediation of BTEX contamination. Bioremediation efficiency relies on the enzyme activity of microorganisms. The primers for DNA amplifications of toluene dioxygenase, 1,2-catechol dioxygenase, and 2,3-catechol dioxygenase were designed for microbial screening. *Pseudomonas putida* dcbflux containing the plasmid, which carries the luxCDABE gene sequence triggered by the toluene dioxygenase promoter, was constructed to detect the concentration and degradation efficiency of BTEX. When the dcbflux strain contacts the pollutant, the tod promoter is activated and turns on the gene of luxCDABE, which emits luminescence. If the concentration is increased or the detection condition is optimized, dcbflux will produce more luminescence. Higher luminescence activity also indicates higher degradation capability. The bioremediation monitoring system established in this research consisted of three parts: (1) bacterial strain screening by DNA analysis, (2) bacterial population quantification and gene copy number analysis by real-time PCR, and (3) enzyme activity assay and pollutant concentration monitoring through the reporter gene system. Two bacterial strains were found to metabolize benzene and toluene at the rate of 8 ppm/mg dry cell weight. Although the concentration of benzene and toluene was near 100 ppm, which inhibited degradation to some extent, the degradation efficiency was ~40%. The temperature and pH of the site's groundwater were near optimal conditions for biological treatment. The bioremediation strategy was to provide the bacterial strains containing the tod dioxygenase gene at the concentration of 106 C FU/g soil and with a supply of oxygen. After a 6-month treatment,

the site was cleaned up, although degradation efficiency had increased from 40% to only 60%. The reporter gene system allows measurement of degradation efficiency and contaminant concentration. By combining the degradation efficiency data with bacterial population data, it is possible to calculate the bioremediation timeframe.

Development and Demonstration of a Field-Deployable Fast Chromotomographic Imager  
O'Dell, Daniel, Master's thesis, Air Force Institute of Technology, Wright-Patterson AFB, 96 pp, 2010

A field-deployable hyperspectral imager utilizing chromotomography (CT), with a direct vision prism (DVP) as the dispersive element, has been constructed at AFIT. This research is focused on the construction and characterization of a CT imager as a prototype for a follow-on International Space Station based instrument. The instrument is currently the fastest known direct-vision prism hyperspectral CT imager. The imager is capable of acquiring spectral data for a transient event lasting less than 0.12 s. The ability to identify potassium, sodium, and absorption features from the instrument's acquired data shows the unit's potential. This research has shown that the instrument has the ability to capture data of static scenes, and more importantly, spectral data for rapidly evolving scenes. <http://handle.dtic.mil/100.2/ADA516496>

Development of a Quantitative PCR Method to Differentiate between Viable and Nonviable Bacteria in Environmental Water Samples

Gedalanga, P.B. and B.H. Olson.

Applied Microbiology and Biotechnology, Vol 82 No 3, p 587-596, Mar 2009

Treatment of pure culture and environmental waters using ethidium monoazide bromide (EMA) at low concentrations (1.0 to 7.5 ug/ml) indicated effective enumeration of viable and viable but nonculturable *Escherichia coli* in pure cultures and effluent samples by quantitative polymerase chain reaction (qPCR) amplification of the *uidA* and *fliC* gene targets at turbidity values <10 NTU. EMA treatment was not effective in primary clarifier and secondary trickling filter effluents where turbidities were  $\geq 10$  NTU. In viable pure cultures, rapidly dividing and senescent cells were most affected by increasing EMA concentrations. Amplification of heat-killed pure bacterial cultures decreased 4 to 6 logs depending on EMA concentration and culture age. The greatest difference was observed in 5-hour cultures using 7.5 ug/ml EMA. Turbidity ( $\geq 100$  NTU) in environmental samples inhibited EMA effectiveness on viability discrimination. Enumeration of *E. coli* in some wastewaters using EMA-qPCR was similar to culture. Overall results suggest that EMA treatment could be incorporated into qPCR assays for the quantification of viable bacteria, increasing assay time by no more than 30 minutes. EMA can be used in routine qPCR assays, but optimum conditions for exposure must be identified for each sample type due to sample matrix effects, such as turbidity.

<http://www.springerlink.com/content/j78r16577674207g/fulltext.pdf>

### Development of a Soil Fugacity Sampler for Determination of Air-Soil Partitioning of Persistent Organic Pollutants under Field Controlled Conditions

Cabrerizo, A., J. Dachs, and D. Barcelo, IDAEA-CSIC, Barcelona, Catalunya, Spain.

Environmental Science & Technology, Vol 43 No 21, p 8257-8263, 2009

Air-soil exchange and partitioning are key processes controlling the fate and transport of persistent organic pollutants (POPs) at regional and global scales. To date, soil fugacity has been estimated either from models of the soil-air partition coefficients, with the associated unavoidable uncertainties, or by experimental procedures in the laboratory with uncertain application in field conditions. The operational soil fugacity sampler presented here ensures optimal field data of the POP fugacity in soil and environmentally relevant surfaces (soil+grass), thereby ensuring accurate soil-air partition coefficients and surface-air fugacity gradients. The sampler flow rate is optimized, sampler reproducibility is assessed, and equilibrium between the gas and soil concentrations of PCBs and PAHs is demonstrated. The development and comprehensive validation of a soil fugacity sampler opens the door to field studies that accurately determine the variables driving soil-air partitioning and fluxes of POPs.

### Development of Biological Sensors Based on Screen-Printed Electrodes for Environmental Pollution Monitoring

Gurban, A.-M., L. Rotariu, M. Tudorache, C. Bala, and T. Noguer.

Sensors for Environment, Health and Security: Advanced Materials and Technologies

Springer, Dordrecht. ISBN: 978-1-4020-9010-3, p 401-413, 2009

Screen-printed electrodes modified with appropriate mediators have been used for reliable determination of dithiocarbamate fungicides and alkylphenols. A sensor based on immobilization of aldehyde dehydrogenase on the surface of a disposable screen-printed carbon-paste electrode, chemically modified with Meldola's blue mediator, was used for the determination of a soil fumigant, metham-sodium and its main toxic metabolite, MITC. This sensor allowed discrimination between metham-sodium and its metabolite MITC, as metham-sodium did not inhibit AIDH, whereas MITC could be detected at 100 ppb levels. Additionally, a new nanocomposite was developed by combination of Prussian blue mediator and single-walled carbon nanotubes (SWNTs). Prussian blue and SWNTs exhibit synergistic electrocatalytic effect toward the hydrogen peroxide reduction. The nanocomposite sensor exhibited excellent sensitivity at 119.62 mA/M/cm<sup>2</sup>, a detection limit of 0.64  $\mu$ M, a fast response time of 10 sec, and a wide linear range up to 2 mM.

### Development of Flow Immunosensors for Organic Pollutants

Gabalton, J.A., A. Martinez, E. Nunez-Delicado, M.A. Gonzalez-Martinez, D. Jornet, R.

Puchades, and A. Maquieira.

Sensors for Environment, Health and Security: Advanced Materials and Technologies

Springer, Dordrecht. ISBN: 978-1-4020-9010-3, p 415-430, 2009

Immunosensing systems for the determination of organic pollutants make use of the competition between the analyte and a labelled hapten for the binding sites of a specific antibody. This process takes place in solution, and the formed immunocomplexes are further captured by immobilized Protein A/G. The activity of the label bound to the capture support is related to the analyte concentration in sample. Capture immunosensors have been applied to

insecticide residues, herbicides, antifouling agents, and antibiotics. Analytes can be determined at the ug/L level and even lower. The total assay time of 18 min per sample can be accelerated to 8.5 min, although sensitivity is partially lost. The possibility of employing the sensors with organic solvent extracts has been studied and methanolic extracts diluted 50/50 (v/v) with buffer have been analyzed. The immunosensing systems have been applied with good results to different matrixes, such as water, food, and soil.

Development of Standard Practice D7365 for Sampling, Preservation and Mitigating Interferences in Water Samples for Analysis of Cyanide  
Sebroski, J.R., Bayer Material Science LLC.

NEMC 2009: The 25th Annual National Environmental Monitoring Conference, 24 presentation slides, 2009

If water samples are not properly preserved in the field, mitigated for interferences, and analyzed with appropriate analytical methods, significant positive or negative bias in the cyanide measurement is likely. Interference can lead to unnecessary permit violations or undetected cyanide discharges, resulting in unnecessary fines or releases to the environment. Several cyanide methods have conflicting interference treatment techniques; some are outdated and do not reflect current technology. Several questions were raised during EPA Methods Update Rule (3/12/07) regarding 40 CFR Part 136.3, Table II Required Containers, Preservation Techniques, and Holding Times, Footnote 6. Determination procedures are too complex for field personnel. EPA intends to propose the following methods for compliance monitoring at 40 CFR Part 136.3: Cyanide Preservation procedures described in ASTM Practice D7365-09, and new or revised consensus standards for total cyanide measurements in ASTM D7511, D7284, and D2036. The 2009 proceedings has other presentations on cyanide determination available through the agenda at [http://nemc.us/index.php?option=com\\_content&view=article&id=92&Itemid=107](http://nemc.us/index.php?option=com_content&view=article&id=92&Itemid=107)  
[http://www.nemc.us/nemc09\\_presents/Presentation-Cyanide-JohnSebroski-8-13-09.pdf](http://www.nemc.us/nemc09_presents/Presentation-Cyanide-JohnSebroski-8-13-09.pdf)

Diesel Transport Monitoring in Simulated Unconfined Aquifers Using Miniature Resistivity Arrays

Sentenac, P., A. Montinaro, and B. Kulassa.

Environmental Earth Sciences, Vol 61 No 1, p 107-114, 2010

In an assessment of diesel plume migration in a scaled aquifer model with a miniaturized electrical resistivity array, injections of 1,000 and 500 ml of diesel, respectively, were injected in both the unsaturated and water-saturated zones of a sand body overlying a clay aquitard. Diesel migration was monitored with a miniature electrode array and an off-the-shelf resistivity meter. Inverted time-lapse electrical resistivity tomography (ERT) data reflect downward and lateral spreading of the diesel plume away from the injection point in the unsaturated zone. Diesel also was imaged to spread upward and laterally away from the injection point in the saturated zone, as controlled by capillary rise. In both cases, subsequent ERT images reflected preferential pooling of diesel on the water table, as well as vertical smearing of pooled diesel in response to simulated water-table fluctuations. Repeat fluid electrical conductivity and dissolved oxygen measurements validate the observed changes in bulk resistivity caused by both diesel injections. Time-lapse ERT imaging of diesel transport is inferred to be feasible and well suited to complementing conventional techniques of intrusive site investigation, although time-lapse 3D or 4D ERT imaging is strongly advocated.

### Direct Push Chemical Sensors for DNAPL

Lieberman, S.H., Space and Naval Warfare Systems Command. Environmental Security Technology Certification Program (ESTCP), Project ER-0109, 170 pp, 2007 [posted Dec 2009]

Project ER-0109 evaluated two technologies: the halogen-specific detector (XSD) and the high resolution fluorescence (HRF) sensing system. The XSD can be operated downhole behind a membrane interface probe (MIP) that samples the soil formation for VOCs. Moving the detector downhole and measuring while the direct-push probe is continuously advanced can increase the spatial resolution of DNAPL detection by an order of magnitude (from feet to inches). Even higher spatial resolution (tenths of inches) can be obtained with a complementary HRF sensing system that can be applied whenever the DNAPL is fluorescent owing to dissolved petroleum products or humic substances. The ability of the characterization techniques to find DNAPL was verified via GeoVIS in situ video imaging. The evaluations were conducted at Naval Air Station North Island, California, and at Marine Corps Base Camp Lejeune, North Carolina. At North Island, the XSD clearly showed several areas that were heavily impacted by halogenated compounds, indicating heavy dissolved-phase halogenated compounds in areas not determined in extensive previous studies. At Camp Lejeune, the XSD clearly delineated zones of chlorinated VOC contamination, and water sampling confirmed the relative accuracy of the XSD concentration vs. depth profiles. Maintaining an acceptable MIP temperature was difficult. While this negatively affected mass transport owing to the presence of a compound (1,1,2,2-tetrachloroethane) that has a high boiling point (146 degrees C) and relatively low vapor pressure (6.36 torr), successful profiling was still accomplished. XSD signal levels were not saturated at Camp Lejeune, even in areas later found to have DNAPL. With the laser-induced fluorescence (LIF) at Camp Lejeune, false positives were encountered; elevated LIF responses did not always prove to be a positive indicator for DNAPL. It should be noted that the XSD-MIP is a screening tool and is incapable of achieving analytical performance in real time on the inherently heterogeneous matrix of the subsurface. Although the logs are not analytically accurate in a quantitative sense, their value lies in their ability to paint an instant picture of the subsurface HVOC distribution. The true value of tools such as the XSD-MIP is their ability to be used in real time to move adaptively about the site, follow gradients toward locations with higher signal levels both laterally and horizontally, and finally pinpoint the true hotspots and likely DNAPL source term areas. [http://www.estcp.org/Technology/upload/ER-0109-FR\\_PMa\\_Final.pdf](http://www.estcp.org/Technology/upload/ER-0109-FR_PMa_Final.pdf)

### Directly Heated High Surface Area Solid Phase Microextraction Sampler for Rapid Field Forensic Analyses

Ramsey, S.A., R.V. Mustacich, P.A. Smith, G.L. Hook, and B.A. Eckenrode. Analytical Chemistry, Vol 81 No 21, p 8724-8733, 2009

A high-surface area solid phase microextraction (HSA-SPME) sampler is described for dynamic sampling at high air velocities (up to several hundred centimeters per second). The sampling device consists of a thin wire coated with carboxen/polydimethylsiloxane (carboxen/PDMS) material, wound in the annular space between two concentric glass tubes, providing a large trapping surface from which analytes are thermally desorbed with little power consumption upon resistive heating of the wire. Desorbed analytes are focused and reconcentrated on a microtrap that is subsequently resistively heated to introduce analytes for GC or GC/MS analysis. BTEX compounds included in a 39-component toxic organics (TO-14) gas mixture were used to evaluate the efficiency of the HSA-SPME sampler. Quantitation of trace-

level BTEX compounds present during weapons cleaning was completed using stepwise calibration. Detection limits of 0.2 to 6.9 ppbv were observed for these analytes using single-ion monitoring GC/MS analysis, and an improvement in sensitivity of several orders of magnitude was achieved when compared to standard dynamic flow SPME with a commercially available 10-mm carboxen/PDMS fiber. The potential for rapid analyte uptake and improved sensitivity using the HSA-SPME design will make it possible to rapidly collect and analyze VOC samples in field settings using a portable hand-held pump and a small, low power GC/MS instrument.

#### A Disposable Organophosphorus Pesticides Enzyme Biosensor Based on Magnetic Composite Nano-Particles Modified Screen Printed Carbon Electrode

Gan, N., X. Yang, D. Xie, Y. Wu, and W. Wen.

Sensors, Vol 10 No 1, p 625-638, 2010

A disposable organophosphorus pesticide (OP) enzyme biosensor based on magnetic composite nanoparticle-modified screen printed carbon electrodes (SPCE) has been developed, beginning with the synthesis of an acetylcholinesterase (AChE)-coated Fe<sub>3</sub>O<sub>4</sub>/Au (GMP) magnetic nanoparticulate (GMP-AChE). GMP-AChE then was absorbed on the surface of a SPCE modified by carbon nanotubes (CNTs)/nano-ZrO<sub>2</sub>/prussian blue (PB)/Nafion (Nf) composite membrane by an external magnetic field to fabricate the OP biosensor (SPCE|CNTs/ZrO<sub>2</sub>/PB/Nf|GMP-AChE). The surface of the biosensor was characterized by scanning electron micrography and X-ray fluorescence spectrometry, and its electrochemical properties were studied by cyclic voltammetry and differential pulse voltammetry. The degree of inhibition (A%) of the AChE by OPs was determined by measuring the reduction current of the PB generated by the AChE-catalyzed hydrolysis of acetylthiocholine (ATCh). In pH = 7.5 KNO<sub>3</sub> solution, the A was related linearly to the concentration of dimethoate in the range from 1.0 x 10<sup>(-3)</sup>-10 ng/mL with a detection limit of 5.6 x 10<sup>(-4)</sup> ng/mL. The recovery rates in Chinese cabbage exhibited a range of 88% to 105%. The results were consistent with the standard GC method. Compared with other enzyme biosensors, the proposed biosensor exhibited high sensitivity and good selectivity with low consumption of sample. Its surface can be easily renewed by removal of the magnet. This convenient, fast, and sensitive voltammetric measurement opens new opportunities for OPs analysis.

<http://www.mdpi.com/1424-8220/10/1/625/pdf>

#### Distribution System Water Quality Monitoring: Sensor Technology Evaluation Methodology and Results--A Guide for Sensor Manufacturers and Water Utilities

Hall, J.S. and J.G. Szabo (National Homeland Security Research Center); S. Panguluri and G.

Meiners (Shaw Environmental & Infrastructure, Inc. Cincinnati, OH).

EPA 600-R-09-076, 60 pp, Oct 2009

This report provides an overview of U.S. EPA's research results from investigating water quality monitoring sensor technologies that might be used to serve as a real-time contamination warning system (CWS) when a contaminant is introduced into a drinking water distribution system. Based on a review of available online water quality monitoring sensor technologies, an early determination was made that it was not technically feasible to identify and quantify the many different types of contaminants that potentially could be introduced into the drinking water

supply/distribution system. Furthermore, because online sensor technologies need to be economically suitable for mass deployment within a distribution system, EPA focused its research on identifying sensor technologies that could be used to detect anomalous changes in water quality due to contamination events. Once a water quality anomaly is detected, the water utility operator is alerted, and further actions (e.g., sampling and analysis) can be undertaken by the operator to identify and quantify the contaminant if necessary. This report focuses on EPA's research on pilot-scale evaluations of available online water quality monitoring sensor instrumentation. Total organic carbon Instruments tested were the Hach astroTOC(tm) UV Process Total Organic Carbon Analyzer; the Sievers(r) 900 On-Line Total Organic Carbon Analyzer; and the Spectro::lyzer(tm)/Carbo::lyzer(tm). Chlorine instruments tested were the Hach CL-17 Free and Total Chlorine Analyzer; the Wallace & Tiernan(r) Depolox(r) 3 plus; the YSI 6920DW; the Analytical Technology, Inc., Model A15/62 Free Chlorine Monitor; and the Rosemount Analytical Model FCL. Online optical instruments tested were the FlowCAM(r); the Hach FilterTrak(tm) 660 sc Laser Nephelometer and Hach 2200 PCX Particle Counter; the BioSentry(r); the Spectro::lyzer(tm)/Carbo::lyzer(tm); and the ZAPS MP-1.  
<http://www.epa.gov/nhsrc/pubs/600r09076.pdf>

#### DNAzyme Self-Assembled Gold Nanoparticles for Determination of Metal Ions Using Fluorescence Anisotropy Assay

Yin, Bin-Cheng, Peng Zuo, Hao Huoa, Xinhua Zhonga, and Bang-Ce Ye.  
Analytical Biochemistry, Vol 401 No 1, p 47-52, 2010

Gold nanoparticles can be exploited to facilitate a highly sensitive and selective metal ion detection based on fluorescence anisotropy assay with metal ion-dependent DNA-cleaving DNAzyme. This assay allows rapid and accurate determination of metal ions in an aqueous medium at room temperature. The method has been demonstrated for determination of Cu<sup>2+</sup> and Pb<sup>2+</sup> ions. The detection sensitivity can be improved to 1 nM by using a "nanoparticle enhancement" approach. The assay was also tested in 384-well plates for high-throughput routine determination of toxic metal ions in environmental samples. The method showed distinct advantages over conventional methods in terms of its potential sensitivity, specificity, and rapid response.

#### Dynamic Sediment Profile Imaging (DySPI): a New Field Method for the Study of Dynamic Processes at the Sediment-Water Interface

Blanpain, O., P.B. du Bois, P. Cugier, R. Lafite, M. Lunven, J. Dupont, E. Le Gall, J. Legrand, and P. Pichavant.

Limnology and Oceanography Methods, Vol 7 No 1, p 8-20, 2009

Sediment profile imaging (SPI) is a widely used technique for mapping benthic habitat quality in soft sediments but limitations exist that make the system ineffective for coarse or indurate sediment investigations and for transport processes studies. To address this problem, a modified system was designed to investigate these processes in situ, on a grain-size scale, with high temporal resolution. A dynamic sediment profile imaging (DySPI) system was constructed with a new mode of penetration, an appropriate design and an imaging system based on high-definition video recording. The supporting frame was instrumented with autonomous sensors to monitor boundary layer characteristics along with video observations. This system was deployed

during spring tide on sediment characterized by a mixture of particle sizes dominated by coarse grains. Appropriate image processing allowed determination of the area of sediment entrained, movement threshold, size of moving particles, instantaneous transport rate and interface profile changes, in addition to usual SPI parameters. However, DySPI is a prototype and further development of the instrument and the image processing are possible to enlarge the scope presented in this study.

#### Easy-to-Use Dipstick Tests for Detection of Lead in Paints Using Non-Cross-Linked Gold Nanoparticle-DNAzyme Conjugates

Mazumdar, D, J. Liu, G. Lu, J. Zhou, and Y. Lu.

Chemical Communications, Vol 46 No 9, p 1416-1418, 7 Mar 2010

Easy-to-use dipstick tests for lead (Pb) have been developed by immobilizing nanoparticle-DNAzyme conjugates on lateral flow devices. Their application for detecting Pb in paints is demonstrated.

#### The Effect of Adding a Standard on the Result of Determination of Polychlorinated Biphenyls in Bottom Sediment Samples

Mechlinska, A., L. Wolska, and J. Namiesnik.

Talanta, Vol 82 No 2, p 627-630, 15 July 2010

The question of the addition of standard substances to sediment samples has not been widely addressed in the subject literature, and yet it is of fundamental importance for obtaining reliable results of determinations. This paper describes the results of a study on the effect of standard addition techniques on the results of determination of PCBs in sediment samples (certified reference material: METRANAL2-river sediment).

#### Effect of Sampler Material on the Uptake of PAHs into Passive Sampling Devices

Allan, I.J., C. Harman, A. Kringstad, and E. Bratsberg.

Chemosphere, Vol 79 No 4, p 470-475, Apr 2010

The effect of sampler material on the passive sampling of PAHs was evaluated in two Norwegian rivers. Low-density polyethylene membranes (LDPE), silicone strips, and semipermeable membrane devices (SPMDs) with the exact same surface area and conformation were exposed in the Drammen River for overlapping exposures of 24 and 51 d under identical hydrodynamic conditions. Dissipation rates of performance reference compounds (PRCs) spiked in all samplers were consistent and demonstrated no significant differences in sampler-water analyte exchange kinetics between the two exposures. The very low variability observed in analyte masses absorbed across sampler types indicates that much of the overall variability in dissolved contaminant concentrations seen in passive sampler intercomparison studies likely is the result of the uncertainty associated with sampler-water partition coefficients and PRC dissipation rates. PRC dissipation rates and ratios of masses absorbed over 51 and 24 d for these compounds demonstrated integrative sampling over 51 d and no major effects of biofouling on sampling. The equivalence of data obtained using silicone strips and SPMDs supports the use of single-phase polymeric passive sampling devices.

### Electrical Conductivity Response of Poly(Phenylene-vinylene)/ Zeolite Composites Exposed to Ammonium Nitrate

Kamonsawas, J., A. Sirivat, S. Niamlang, P. Hormnirun, and W. Prissanaroon-Ouajai. *Sensors*, Vol 10 No 6, p 5590-5603, 2010

A safe method is required to detect explosives in advance via tailored gas sensors that can sense various volatiles of typical bomb chemicals: cyclotrimethylenetrinitramine (RDX), trinitrotulene (TNT), and ammonium nitrate. Poly(p-phenylenevinylene) (PPV) was chemically synthesized via the polymerization of p-xylene-bis(tetrahydrothiophenium chloride) monomer and doped with H<sub>2</sub>SO<sub>4</sub>. To improve the electrical conductivity sensitivity of the conductive polymer, zeolites Y (Si/Al = 5.1, 30, 60, 80) were added into the conductive polymer matrix. All composite samples show definite positive responses towards NH<sub>4</sub>NO<sub>3</sub>. The electrical conductivity sensitivities of the composite sensors increase linearly with increasing Si/Al ratio, with values of 0.201, 1.37, 2.80, and 3.18, respectively. The interactions between NH<sub>4</sub>NO<sub>3</sub> molecules and the PPV/zeolite composites with respect to the electrical conductivity sensitivity were investigated using infrared spectroscopy. <http://www.mdpi.com/1424-8220/10/6/5590/pdf>

### Electrochemical Microsensors for the Detection of Cadmium(II) and Lead(II) Ions in Plants

Krystofova, O., L. Trnkova, V. Adam, J. Zehnalek, J. Hubalek, P. Babula, and R. Kizek. *Sensors*, Vol 10 No 6, p 5308-5328, 2010

This work compared three electro-chemical instruments [a standard potentiostat (Autolab), a commercially available miniaturized potentiostat (PalmSens) and a homemade micropotentiostat] for easy-to-use and sensitive determination of cadmium(II) and lead(II) ions. The lowest detection limits (hundreds of pM) for both metals was achieved by use of the standard potentiostat, followed by the miniaturized potentiostat (tens of nM) and the homemade instrument (hundreds of nM). All the potentiostats were sensitive enough to evaluate contamination of the environment as the environmental limits for both metals are higher than the instruments' detection limits. The investigators tested all the potentiostats and working electrodes for analysis of environmental samples (rainwater, flour, and plant extract) with artificially added cadmium(II) and lead(II). With similar results obtained for all potentiostats, the investigators chose a homemade instrument with a carbon tip working electrode for subsequent environmental experiments, in which they analyzed maize and sunflower seedlings and rainwater obtained from various sites in the Czech Republic. <http://www.mdpi.com/1424-8220/10/6/5308/pdf>

### Electrode-Based Approach for Monitoring In Situ Microbial Activity During Subsurface Bioremediation

Williams, K.H., K.P. Nevin, A. Franks, A. Englert, P.E. Long, and D.R. Lovley. *Environmental Science & Technology*, Vol 44 No 1, p 47-54, 2010

Current production by microorganisms colonizing subsurface electrodes and its relationship to substrate availability and microbial activity was evaluated in an aquifer undergoing bioremediation. Borehole graphite anodes were installed downgradient from a region of acetate injection designed to stimulate bioreduction of U(VI). The cathodes consisted of graphite electrodes embedded at the ground surface. Significant increases in current density ( $\leq 50$  mA/m<sup>2</sup>) tracked delivery of acetate to the electrodes, dropping rapidly when acetate inputs were discontinued. An upgradient control electrode not exposed to acetate produced low, steady currents ( $\leq 0.2$  mA/m<sup>2</sup>). Elevated current was strongly correlated with uranium removal

but minimal correlation existed with elevated Fe(II). Confocal laser scanning microscopy of electrodes revealed firmly attached biofilms, and analysis of 16S rRNA gene sequences indicated the electrode surfaces were dominated (67 to 80%) by *Geobacter* species. This is the first demonstration that electrodes can produce readily detectable currents despite long-range (6 m) separation of anode and cathode, and the results suggest that oxidation of acetate coupled to electron transfer to electrodes by *Geobacter* species was the primary source of current. It is expected that current production can serve as an effective proxy for monitoring in situ microbial activity in a variety of subsurface anoxic environments.

<http://www.osti.gov/bridge/purl.cover.jsp;jsessionid=6541E437B0EC1A9FC01BA7BF79F97491?purl=/980916-AtXHtu/>

#### Electrode Voltages Accompanying Stimulated Bioremediation of a Uranium-Contaminated Aquifer

Williams, K.H., A.L. N'Guessan, J. Druhan, P.E. Long, S.S. Hubbard, D.R. Lovley, and J.F. Banfield.

LBNL-2960E, 42 pp, 2009 [published in *Journal of Geophysical Research* 115(5):(2010)]

Inability to track the products of subsurface microbial activity during stimulated bioremediation has limited its implementation. Spatiotemporal changes in electrode potentials (EP) were used to track the onset and persistence of stimulated sulfate-reducing bacteria in a uranium-contaminated aquifer undergoing acetate amendment. Following acetate injection, anomalous voltages approaching -900 mV were measured between copper electrodes within the aquifer sediments and a single reference electrode at the ground surface. Onset of EP anomalies correlated in time with both the accumulation of dissolved sulfide and the removal of uranium from groundwater. The anomalies persisted for 45 days after halting acetate injection. Current-voltage and current-power relationships between measurement and reference electrodes exhibited a galvanic response, with a maximum power density of 10 mW/m<sup>2</sup> during sulfate reduction. The EP anomalies likely resulted from electrochemical differences between geochemically reduced regions and areas having higher oxidation potential. Following the period of sulfate reduction, EP values ranged from -500 to -600 mV and were associated with elevated concentrations of ferrous iron. Within 10 days of the voltage decrease, uranium concentrations rebounded from 0.2 to 0.8 uM, a level still below the background value of 1.5 uM. These findings demonstrate that EP measurements provide an inexpensive and minimally invasive means for monitoring the products of stimulated microbial activity within aquifer sediments and are capable of verifying maintenance of redox conditions favorable for the stability of bioreduced contaminants, such as uranium. <http://www.osti.gov/bridge/servlets/purl/980917-TiMABX/>

#### Elucidating MTBE Degradation in a Mixed Consortium Using a Multidisciplinary Approach

Bastida, F., M. Rosell, A.G. Franchini, J. Seifert, S. Finsterbusch, N. Jehmlich, S. Jechalke, M. von Bergen, and H.H. Richnow.

FEMS Microbiology Ecology, Vol 73 No 2, p 370-384, 2010

The structure and function of a microbial community capable of biodegrading MTBE was characterized using compound-specific stable isotope analysis (CSIA), clone libraries, and stable isotope probing of proteins (Protein-SIP). The enrichment culture (US3-M), which originated from a gasoline-impacted site, was enriched on MTBE as the sole carbon source. 16S rRNA gene libraries revealed sequences belonging to *M. petroleiphilum* PM1, *Hydrogenophaga* sp.,

Thiothrix unzii, Rhodobacter sp., Nocardiodes sp. and different Sphingomonadaceae bacteria. Protein-SIP analysis of the culture grown on (13)C-MTBE as the only carbon source revealed that proteins related to members of the Comamonadaceae family, such as Delftia acidovorans, Acidovorax sp. or Comamonas sp., were not (13)C-enriched, whereas proteins related to M. petroleiphilum PM1 showed an average incorporation of 94.5 atom%(13)C. These results indicate a key role for this species in the degradation of MTBE within the US3-M consortia. The combination of CSIA, molecular biology, and protein-SIP facilitated the analysis of an MTBE-degrading mixed culture from a functional and phylogenetic point of view.

#### Estimation of Biological Oxygen Demand and Chemical Oxygen Demand for Combined Sewer Systems Using Synchronous Fluorescence Spectra

Hur, Jin, Bo-Mi Lee, Tae-Hwan Lee and Dae-Hee Park.

Sensors, Vol 10 No 4, p 2460-2471, 2010

Real-time monitoring of water quality in a sewer system is required for efficient sewer network design because it provides information on the precise loading of pollutant to wastewater treatment facilities and the impact of loading on receiving water. Synchronous fluorescence spectra and the first derivatives were investigated using wastewater samples collected in sewer systems in urban and non-urban areas, and the optimum fluorescence feature was explored for the estimation of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) concentrations of the samples. The temporal variations in BOD and COD showed a regular pattern for urban areas, while they were relatively irregular for non-urban areas. Irrespective of the sewer pipes and the types of the areas, two distinct peaks were identified from the synchronous fluorescence spectra, corresponding to protein-like fluorescence (PLF) and humic-like fluorescence (HLF), respectively. HLF in sewer samples appears to be associated with fluorescent whitening agents. Five fluorescence characteristics were selected from the synchronous spectra and the first-derivatives. Among the selected fluorescence indices, a peak in the PLF region (i.e., Index I) showed the highest correlation coefficient with both BOD and COD. A multiple regression approach based on suspended solid (SS) and Index I used to compensate for the contribution of SS to BOD and COD revealed an improvement in the estimation capability, showing good correlation coefficients of 0.92 and 0.94 for BOD and COD, respectively. <http://www.mdpi.com/1424-8220/10/4/2460/pdf>

#### Estimation of Seepage Rates in a Losing Stream by Fiber-Optic High-Resolution Vertical Temperature Profiling

Vogt, T, P. Schneider, L. Hahn-Woernle, and O.A. Cirpka.

Journal of Hydrology, Vol 380 Nos 1-2, p 154-164, 2010

This paper presents a method for high-resolution vertical temperature profiling in surface-water sediments for detailed quantification of seepage flux over depth and time. The method is based on fiber-optic distributed temperature sensing, in which temperature profiles along an optical fiber are obtained by Raman scattering. An optical fiber is wrapped around a 2-inch PVC tube and installed vertically within the stream bed sediment. The wrapping transfers the spatial resolution along the fiber of 1 m to a vertical resolution of about 5 mm. The high-resolution temperature profiler was tested at a losing reach of the Swiss prealpine River Thur, resulting in a 20-day long temperature time series with a temporal resolution of 10 min. The time

series is analyzed by means of dynamic harmonic regression to obtain the diurnal contributions of the measured time series at all depths and time points. The time for the diurnal temperature signal to reach the observation depth and the associated attenuation of the signal are calculated from the phase angles and amplitudes of the diurnal contributions. The time shift results in apparent rapid diurnal temperature propagation, which is converted into a seepage rate by fitting the data to the analytical solution for convective-conductive heat transfer in a semi-infinite, uniform, 1-D domain with a sinusoidal surface temperature. The high spatial resolution allows the location of discontinuities in the river bed that would have remained undetected if temperature had been measured only at a few individual depths. This is a particular strength of the fiber-optic high-resolution temperature profiler. The time series also give evidence of sporadic high infiltration rates at times of high water tables.

#### Evaluation of a Total Reflection X-Ray Fluorescence Spectrometer in the Determination of Arsenic and Trace Metals in Environmental Samples

Juvonen, R., A. Parviainen, and K. Loukola-Ruskeeniemi.

Geochemistry: Exploration, Environment, Analysis, Vol 9 No 2, p 173-178, 2009

The suitability of the PicoTAX total reflection X-ray fluorescence (TXRF) spectrometer was studied for determination of As and trace metals in Au-Cu sulfide mine tailings leached with aqua regia and in water affected by acid mine drainage. Results for 12 water and 16 tailings samples were compared with accredited methods: inductively coupled plasma-atomic emission spectrometry and inductively coupled plasma-mass spectrometry. Approximate method detection limits (MDL) for water samples, based on reference sample analyses, are in the range of 20 ug/L for As, Cr, Pb, and Zn and 5 to 10 ug/L for Co, Cu, Ni, V, and Mn. MDLs for aqua regia leach, calculated using reagent blank values, were  $\leq 20$  (mg/kg) for As, Co, Cr, Cu, Mn, Ni, V, and Zn. Results indicated that TXRF can be recommended merely as a preliminary technique for selecting samples.

#### Evaluation of the Use of Performance Reference Compounds in an Oasis-HLB Adsorbent Based Passive Sampler for Improving Water Concentration Estimates of Polar Herbicides in Freshwater

Mazzella, N., S. Lissalde, S. Moreira, F. Delmas, P. Mazellier, and J.N. Huckins.

Environmental Science & Technology, Vol 44 No 5, p 1713-1719, 2010

The use of performance reference compounds (PRC) spiked into the Polar Organic Chemical Integrative Sampler (POCIS) adsorbent for in situ calibration can improve the semiquantitative nature of water concentration estimates based on this type of passive sampler. In this work, deuterium labeled atrazine-desisopropyl (DIA-d5) was chosen as PRC because of its relatively high fugacity from Oasis HLB (the POCIS adsorbent used) and earlier evidence of its isotropic exchange. In situ calibration of POCIS spiked with DIA-d5 was performed, and the resulting time-weighted average concentration estimates were compared with similar values from an automatic sampler equipped with Oasis HLB cartridges. Before PRC correction, water concentration estimates based on POCIS data sampling rates from a laboratory calibration exposure were systematically lower than the reference concentrations obtained with the automatic sampler. Use of the DIA-d5 PRC data to correct POCIS sampling rates narrowed differences between corresponding values derived from the two methods. Application of PRCs for in situ calibration seems promising for improving POCIS-derived concentration estimates of

polar pesticides, but careful attention must be paid to the minimization of matrix effects when the quantification is performed by HPLC-ESI-MS/MS.

#### An EXCEL(r) Workbook for Identifying Redox Processes in Ground Water

Jurgens, B.C., P.B. McMahon, F.H. Chapelle, and S.M. Eberts.

U.S. Geological Survey Open-File Report 2009-1004, 15 pp, 2009

The reduction/oxidation (redox) condition of ground water affects the concentration, transport, and fate of many anthropogenic and natural contaminants. The redox state of a ground-water sample is defined by the dominant type of reduction/oxidation reaction (redox process) occurring in the sample, as inferred from water-quality data. Because of the difficulty in defining and applying a systematic redox framework to samples from diverse hydrogeologic settings, many regional water-quality investigations do not attempt to determine the predominant redox process in ground water. Recently, a redox framework was applied to a large group of samples from 15 principal aquifer systems in the United States to examine the effect of redox processes on water quality. This framework was expanded to use measured sulfide data to differentiate between iron(III)- and sulfate-reducing conditions. These investigations showed that a systematic approach to characterize redox conditions in ground water could be applied to datasets from diverse hydrogeologic settings using water-quality data routinely collected in regional water-quality investigations. This report describes a workbook developed in Microsoft Excel that assigns the predominant redox process to samples using the framework created by McMahon and Chapelle (2008) and expanded by Chapelle and others. Assignment of redox conditions is based on concentrations of dissolved oxygen, nitrate, manganese, iron, sulfate, and sulfide. The logical arguments for assigning the predominant redox process to each sample are performed by a program called from buttons on the main worksheet. The number of samples that can be analyzed is only limited by the number of rows in Excel (65,536 for the 2003 and XP versions; 1,048,576 for 2007), and is therefore appropriate for large datasets.

<http://pubs.usgs.gov/of/2009/1004/>

#### Feasibility of New Technology to Comprehensively Characterize Air Emissions from Full Scale Open Burning and Open Detonation

Kemme, M., U.S. Army Engineer Research and Development Center.

2010 Global Demilitarization Symposium and Exhibition, 10-13 May 2010, Tulsa, Oklahoma.

28 presentation slides, 2010

Tooele Army Depot facilitated a multi-agency collaborative effort to better understand open burning and open detonation (OB/OD) emissions during a study conducted in March 2010. The participants are taking various technologies and using them simultaneously to determine their capability to measure OB/OD emissions data in real time. The study is being funded by the Strategic Environmental Research and Development Program (SERDP) Project WP-1672, under the supervision of Dr. Byung J. Kim of the U.S. Army Engineer Research and Development Center. SERDP, DOE, and U.S. EPA are joined in this effort by other federal and non-federal organizations. The OB/OD tests were conducted so the various agencies could use different methods to sample the emissions in real time simultaneously. The Integrated Measurement Systems for this study included the Flyer, optical remote sensing-particulate matter (ORS-PM) sampling, and the PM-10 measurement system. Developed by Dr. Brian Gullett with the EPA,

the Flyer is an aerial, balloon-borne instrument package used for measuring particulate matter and gases. Integrated Systems Solutions Inc., worked with EPA's National Risk Management Research Laboratory team to get the Flyer in the air using a tethered balloon with a sail, which helped stabilize the Flyer while in the air and allowed it to stay inside the plume for the longest possible time. The ORS gaseous measurement system consists of active and passive open-path Fourier Transform Infrared (OP-FTIR) spectrometers and ultraviolet differential absorption spectrometers (UV-DOAS). A team also used a PM-10 measurement system consisting of micro-pulse light (MPL) and detection and ranging and tapered element oscillating microbalances (TEOMs). To gather the appropriate amount of data, emissions were created using 100 pounds of M1 per burn pan during the open-burn process, and 50 to 100 pounds of TNT flakes per detonation during the open detonation process. The chemicals undergo a chemical change once they are burned, and the teams are trying to identify what is in the plume produced by OB/OD operations. The purpose is to be able to say with certainty that the plume is not toxic or, if the emissions are of concern, to find another demilitarization technique. The final technical report for this study should be completed by June 31.

[https://midas.dac.army.mil/Symposium/2010/10\\_Proceedings/B6\\_Kemme.pdf](https://midas.dac.army.mil/Symposium/2010/10_Proceedings/B6_Kemme.pdf)

Field Demonstration: Application of IS Methods for Arsenic in Soils

Black, Kelly, Neptune and Company, Inc.

E2S2 2010: Environment, Energy Security, and Sustainability Symposium and Exhibition, 14-17 June 2010, Denver, Colorado. National Defense Industrial Association (NDIA), Abstract 10206, 31 presentation slides, 2010

The Interstate Technology Regulatory Council (ITRC) has established an Incremental Sampling Methodologies (ISM) Team. This team will issue an ITRC technical regulation document on the use of ISM. To assist in preparation of that document, a field demonstration of ISM was conducted in Florida in January 2010. The field demonstration was conducted at a defunct golf course that had been treated with arsenic-based herbicides. This study included comparison of several different sampling and analysis components of ISM, including discrete vs. incremental samples; 30-increment samples vs. 100-increment samples; typical sample prep. vs. "pancaking" and subsampling; and grinding vs. not grinding. The data collected in this study will be analyzed and presented to help inform discussions on the pros and cons of incremental sampling. The results and lessons learned from this study are reviewed.

<http://e2s2.ndia.org/schedule/Documents/Abstracts/10206.pdf>

Field Measurements and Guidelines for the Application of Wireless Sensor Networks to the Environment and Security

Jimenez, V.P.G. and A.G. Armada.

Sensors, Vol 9 No 12, p 10309-10325, 2009

Wireless sensor network (WSN) designs frequently are focused on applications and omit transmission problems. A measurement campaign has been carried out using one of the most commonly used WSN platforms, the micaZ from Crossbow(r). Based on these measurements, guidelines are provided for deployment of a robust and reliable WSN. The results are focused on security and environmental applications but can also be extrapolated to other scenarios. From the transmission point of view, a dense WSN is one of the best choices to overcome many

transmission problems, such as the existence of a transitional region, redundancy, forwarding, obstructions, or interference with other systems.

<http://www.mdpi.com/1424-8220/9/12/10309/pdf>

### Field Performance of Seven Passive Sampling Devices for Monitoring of Hydrophobic Substances

Allan, I.J., K. Booij, A. Paschke, B. Vrana, G.A. Mills, and R. Greenwood.  
Environmental Science & Technology, Vol 43 No 14, p 5383-5390, 2009

The performance of seven passive sampling devices for the monitoring of dissolved concentrations of PAHs, PCBs, hexachlorobenzene, and p,p'-DDE was evaluated through simultaneous field exposures of 7 to 28 days in the River Meuse (The Netherlands). Data from the Chemcatcher, low density polyethylene membranes, two versions of the membrane-enclosed sorptive coating (MESCO) sampler, silicone rods, silicone strips, and semipermeable membrane devices (SPMD) were assessed through rate of dissipation of performance reference compounds (PRCs), mass of analyte absorbed by the samplers, and time-weighted average concentration (C(TWA)) data. Consistent PRC data throughout the range of samplers tested here confirmed the transition from membrane- to boundary layer-controlled exchange at  $\log K(ow)$  4.5 to 5.0. The comparison of sampler surface area-normalized masses absorbed for analytes under boundary layer-control showed some variability between samplers that can be attributed to the conformation and deployment of the various samplers and to the uncertainty associated with the analysis conducted in different laboratories. Despite different modes of calculation, relatively consistent C(TWA) were obtained for the different samplers. The observed variability might be due to the uncertainty of sampler-water partition coefficients and the extrapolation of analyte uptake rates at the high  $\log K(ow)$  range (under boundary layer-controlled exchange) from a narrow PRC data range, and these issues require further work.

### Field Performance of the Chemcatcher Passive Sampler for Monitoring Hydrophobic Organic Pollutants in Surface Water

Vrana, B., G.A. Mills, P.E. Leonards, M. Kotterman, M. Weideborg, J. Hajslova, V. Kocourek, M. Tomaniova, J. Pulkrabova, M. Suchanova, K. Hajkova, S. Herve, H. Ahkola, and R. Greenwood .

Journal of Environmental Monitoring, Vol 12 No 4, p 863-872, 9 Apr 2010

Six field trials were carried out to assess the performance of the Chemcatcher passive sampler alongside spot sampling for monitoring priority hydrophobic organic pollutants (PAHs and organochlorine pesticides) in a wide range of conditions in surface water. The trials were performed in three European rivers in two seasons (April-June and September-October 2004). Samplers spiked with performance reference compounds (PRCs) were deployed for either 14 or 28 days. Ten spot samples of water were collected over the course of the trial and filtered through a 0.7  $\mu$ m glass fiber filter. Concentrations of pollutants measured using the Chemcatcher were compared with the average concentrations found in spot samples. This study describes the operational performance of Chemcatcher for measuring hydrophobic ( $\log K(ow)$  3.7 to 6.8) chemicals in surface water. Highest sensitivity was achieved for compounds with a favourable combination of low instrument quantification limits and high sampling rates--dieldrin, lindane, hexachlorobenzene, pentachlorobenzene, and PAHs with less than five aromatic rings. The direct

comparison of time weighted average (TWA) concentrations (mostly close to method limits of detection) obtained using passive and spot sampling was possible for hexachlorobenzene, lindane, and PAHs < 4 rings.

#### Fluorescence-Based Sensing of 2,4,6-Trinitrotoluene (TNT) Using a Multi-Channeled Poly(methyl methacrylate) (PMMA) Microimmunosensor

Charles, P.T., A.A. Adams, P.B. Howell, S.A. Trammell, J.R. Deschamps, and A.W. Kusterbeck. *Sensors*, Vol 10 No 1, p 876-889, 2010

Fluorescence immunoassays employing monoclonal antibodies directed against the explosive TNT were conducted in a multi-channel microimmunosensor. The multi-channel microimmunosensor was prepared in poly (methyl methacrylate) (PMMA) via hot embossing from a brass molding tool. The multi-channeled microfluidic device was sol-gel coated to generate a siloxane surface that provided a scaffold for antibody immobilization. AlexaFluor-cadaverine-trinitrobenzene (AlexaFluor-Cad-TNB) was used as the reporter molecule in a displacement immunoassay. The limit of detection was 1 to 10 ng/mL (ppb) with a linear dynamic range that covered three orders of magnitude. In addition, antibody cross reactivity was investigated using RDX, HMX, 2,4-dinitrotoluene (DNT), 4-nitrotoluene (4-NT) and 2-amino-4,6-DNT. <http://www.mdpi.com/1424-8220/10/1/876/pdf>

#### Fluorescent Film Sensor for Vapor-Phase Nitroaromatic Explosives via Monolayer Assembly of Oligo(diphenylsilane) on Glass Plate Surfaces

He, G., G. Zhang, F. Lu, and Y. Fang, *Chemistry Materials*, Vol 21, p 1494-1499, 2009

Fast and sensitive detection of nitroaromatic compounds (NACs)--TNT and DNT--is of major importance for finding hidden explosives in airport luggage and in mail, screening people for explosives, and detecting buried landmines. This paper reports the preparation of a fluorescent film sensor by chemical assembly of oligo(diphenylsilane)s on a glass plate surface for the detection of NACs in vapor phase. This design combines the advantages of fluorescent films based on single-layer chemistry and the signal amplification effect of conjugated polymers. It provides an effective way to create novel fluorescence sensing films for NACs explosives. The advantages have been demonstrated experimentally by the super-sensitive response of the above-mentioned film to the presence of trace amounts of NACs in vapor phase. Further experiments showed that the sensing process is reversible and that commonly encountered interfering substances offer no interference to this process. Fluorescence lifetime measurements revealed that the quenching is static in nature. The super-sensitive response, the reversibility, and the freedom from interference of the sensing process make the film a promising NACs sensor. <http://img1.chem17.com/5/20091104/633929307219797500.pdf>

#### Fluorescent Silicate Materials for the Detection of Paraoxon

Johnson, B.J., B.J. Melde, C. Thomas, A.P. Malanoski, I.A. Leska, P.T. Charles, D.A. Parrish, and J.R. Deschamps. *Sensors*, Vol 10 No 3, p 2315-2331, 2010

Porphyrins are a family of highly conjugated molecules that strongly absorb visible light and fluoresce intensely. These molecules are sensitive to changes in their immediate environment and have been widely described for optical detection applications. Surfactant-

templated organosilicate materials have been described for the semi-selective adsorption of small molecule contaminants. These structures offer high surface areas and large pore volumes within an organized framework. The organic bridging groups in the materials can be altered to provide varied binding characteristics. This effort seeks to utilize the tunable binding selectivity, high surface area, and low materials density of these highly ordered pore networks and to combine them with the unique spectrophotometric properties of porphyrins. In the porphyrin-embedded materials (PEMs), the organosilicate scaffold stabilizes the porphyrin and facilitates optimal orientation of porphyrin and target. The materials can be stored under ambient conditions and offer exceptional shelf-life. The authors report on the design of PEMs with specificity for organophosphates (e.g., pesticides) and compounds of similar structure.

<http://www.mdpi.com/1424-8220/10/3/2315/pdf>

A Forensic Chemistry Investigation of Chlorinated Aliphatic Hydrocarbon Contamination in a Karst Aquifer at Camp Stanley Storage Activity, Texas

Edwards, R., Noblis, San Antonio, TX.

EMDQ 2010: DoD Environmental Monitoring and Data Quality Workshop, 12-16 April 2010, Louisville, Kentucky. 20 presentation slides, 2010

A forensic investigation uses multiple lines of chemical evidence to answer questions not readily answered using a more limited approach based on a few routine analyses. This presentation discusses several tools--compound-specific stable isotope analysis and analysis of stable isotopes of water--used in the forensic chemistry investigation of a DoD site with chlorinated aliphatic hydrocarbon contamination in the groundwater. The site consists of highly fractured limestone with some karst development, depth to groundwater fluctuates between 50 and 250 feet bgs, and two aquifer members separated by a fractured shale formation. Contamination is found in both aquifer members. An in situ bioreactor was implemented successfully to promote microbial dechlorination of contaminants, but evidence suggests a second source of contamination. Contaminant transport was incompletely characterized in the highly fractured and complex aquifer, and extraction of the contaminated groundwater was limited by the high cost of installing additional extraction wells. A novel technique was developed to permit the calculation of the initial carbon stable isotope ratio of undegraded contaminant even though the parent contaminant (PCE) had degraded in situ to daughter products. The technique provided a critical line of evidence to establish the presence of a second source and guided surgical placement of a new extraction well to maximize contaminant removal. The combined use of concentration data, ratios of contaminants at different locations, and stable isotope analysis pinpointed the source of contamination of the lower aquifer member. Stable isotope analysis was used to evaluate contaminant transport from the source areas. The site was identified as the source of contamination at distant wells based on the stable isotope ratios of contaminants and groundwater.

[https://www.regonline.com/custImages/240809/Technical%20Presentations/3%20-%20Edwards\\_rev1.pdf](https://www.regonline.com/custImages/240809/Technical%20Presentations/3%20-%20Edwards_rev1.pdf)

Fractured Bedrock Field Methods and Analytical Tools, Volume I : Main Report  
Doe, T.

Science Advisory Board for Contaminated Sites in British Columbia, 99 pp, Apr 2010

Fractures confine flow to a network that can introduce high degrees of discontinuity, anisotropy, and heterogeneity to a hydrogeologic system. Associated with contaminant transport in fractured porous media are additional concerns with the retardation and storage created by matrix diffusion. Flow involving immiscible, nonaqueous-phase liquids creates further complexity with capillary and gravity forces. This guidance describes fracture-based site characterization methods and how they should be used in a staged program of site assessment. The appendices contain additional background material on the basics of fracture flow with further discussion of characterization methodologies and numerical simulation approaches. Recognition that a limited number of fractures usually dominates the flow is central to the assessment strategy. A site assessment must focus on identifying and characterizing the controlling fractures (e.g., specific fractures or types such as exfoliation joints, bedding planes, or faults) using modern tools such as flow logging and optical televiewer logging. Single-well and multi-well pump tests also provide insight to the geometry of the conducting fracture network. Multi-zone piezometers are necessary to isolate flowing fractures and to map fracture connectivities from natural and human-induced perturbations. Matrix diffusion, which can retard contaminant migration significantly, requires attention to rock matrix porosity and porosity developed by weathering and alteration around fractures. Immiscible contaminants require an assessment of multiphase flow. For fractured bedrock assessment, an iterative and integrative approach is vital. Iterative means creating a conceptual model, testing the model with data, and revising the model as information is gathered. Integrative means using all the geologic, hydrologic, geophysical, and geochemical data to mutually constrain site interpretations.  
<http://www.sabcs.chem.uvic.ca/fracturedbedrock.html>

Fractured Bedrock Field Methods and Analytical Tools, Volume 2: Appendices  
Doe, T.

Science Advisory Board for Contaminated Sites in British Columbia, 159 pp, Apr 2010

In Volume 2, Section A discusses fundamental aspects of the flow and transport behavior of fractures under six topic headings: geologic origins of fractures and faults; single fracture flow: the parallel plate analog; transport in single fractures; fracture-matrix interaction: dual porosity flow and matrix diffusion; multiphase flow in a single fracture; and fracture network geometric properties and their statistical description. Section B covers fractured bedrock characterization methods (geological characterization, geophysics, hydraulic characterization, monitoring systems and borehole completions), and Section C discusses modeling.  
<http://www.sabcs.chem.uvic.ca/fracturedbedrock.html>

Functional Gene Array-Based Analysis of Microbial Community Structure in Groundwaters with a Gradient of Contaminant Levels

Waldron, P.J., L. Wu, J.D. Van Nostrand, C.W. Schadt, D.B. Watson, P.M. Jardine, A.V. Palumbo, T.C. Hazen, and J. Zhou.

LBNL-2635E, 29 pp, 2009 [Published in Environmental Science & Technology, Vol 43 No 10, p 3529-3534, 2009]

Six groundwater monitoring wells from the Field Research Center of DOE's Environmental Remediation Science Program at Oak Ridge, Tennessee, were selected to

compose a gradient of pH, nitrate, and heavy metal contamination. DNA from the groundwater bacterial community was analyzed with a functional gene array containing 2,006 probes for the detection of genes involved in metal resistance, sulfate reduction, contaminant degradation, and carbon and nitrogen cycling. Diversity decreased in relation to the level of contamination within each well, and each community exhibited a different distribution of genes. Heatmaps of metal resistance genes and nirK and nirS genes indicate that highly contaminated wells had lower gene diversity but greater signal intensity for detected genes. Wells with the highest sulfate concentrations had the greatest diversity and signal intensity for dsrAB genes. A greater number of carbon fixation genes (cbbL, cbbM) were detected than fermentation genes in all wells. A variety of organic contaminant degradation genes were also detected. Results of Mantel tests and canonical correspondence analysis indicate that nitrate, sulfate, pH, uranium, and technetium have a significant ( $p < 0.05$ ) effect on bacterial community structure. This study provides an overall picture of bacterial community structure in contaminated environments across many different functional genes and shows that diversity can vary widely in relation to the degree of contamination. <http://www.osti.gov/bridge/purl.cover.jsp?purl=/973687-5kqEML/>

#### Geochip-Based Analysis of Functional Microbial Communities in a Bioreduced Uranium-Contaminated Aquifer during Reoxidation by Oxygen

Van Nostrand, J.D., W.-M. Wu, L. Wu, Y. Deng, J. Carley, S. Carroll, Z. He, B. Gu, J. Luo, C.S. Criddle, D.B. Watson, P.M. Jardine, J.M. Tiedje, T.C. Hazen, and J. Zhou. *Environmental Microbiology*, Vol 11 No 10, p 2611-2626, 2009

A pilot-scale system was established for in situ biostimulation of U(VI) reduction by ethanol addition at DOE's Field Research Center in Oak Ridge, Tennessee. After achieving U(VI) reduction, the bioreduced area was tested further to determine the stability of the reduced U under a resting state (no ethanol injection) and during reoxidation via introduction of dissolved oxygen (DO). GeoChip, a comprehensive 50mer functional gene array involved in N, S, and C cycling, metal resistance, and contaminant degradation, was used to monitor the dynamics of microbial community structure and function in groundwater from two monitoring wells. Detrended correspondence analysis showed a substantial change in community structure after ethanol injections resumed. The communities experienced an increase in the number of genes and an increased diversity; however, while the number of genes detected changed, the relative abundance of most gene groups detected showed little change over the course of the study. An increase in DO did result in a decrease in the relative abundance of dsr genes, but no change was detected for cytochrome c genes. During the reoxidation period, U(VI) increased, suggesting a reoxidation of previously reduced U(IV), but after DO was controlled, U(VI) reduction resumed and returned to pre-reoxidation levels. Cluster analysis of individual gene groups showed an overlap of functional genes that demonstrated a functional redundancy within these communities, which might be responsible for the rapid recovery of the community after perturbation. <http://public.ornl.gov/orific/Van%20Nostrand%20et%20al%202009%20Environ%20Microbiol.pdf>

### Geophysical Characterization of the Large-Scale Internal Structure of a Waste Rock Pile from a Hard Rock Mine

Anterrieu, O., M. Chouteau, and M. Aubertin.

Bulletin of Engineering Geology and the Environment, 2010 [epub ahead of printing]

A geophysical investigation was conducted on a waste rock pile of a polymetallic mine to define its internal structure. Three different areas of the pile were investigated using electrical resistivity imaging, ground-penetrating radar, and electromagnetic conductivity techniques. The surveys were conducted on the top of the pile, along the slope of the upper bench, and in several boreholes drilled into the pile. Laboratory testing was also undertaken on samples taken from three exploratory trenches dug into the top surface to ascertain their geochemical and hydrogeological properties. The geophysical surveys indicated a general horizontal layering in the core of the pile and dipping stratification parallel to the slope along the edges. These features are related to the method of construction and to a change in the waste rock characteristics. Integrating all the data confirmed that such geophysical investigations can provide valuable information to assess the internal structure of a waste rock pile. The ensuing structural model can then be used to construct a hydrogeological model, which can form a basis for evaluating the flow of water (and gas) in the pile.

### Geophysical Monitoring of Coupled Microbial and Geochemical Processes During Stimulated Subsurface Bioremediation

Williams, K.H., A. Kemna, M. Wilkins, J. Druhan, E. Arntzen, L. N'Guessan, P.E. Long, S.S. Hubbard, and J.F. Banfield.

Environmental Science & Technology, Vol 43 No 17, p 6717-6723, 2009

This paper describes the use of a minimally invasive geophysical technique to monitor stimulated microbial activity during acetate amendment in an aquifer near Rifle, Colorado. During electrical induced polarization (IP) measurements, spatiotemporal variations in the phase response between imposed electric current and the resultant electric field correlated with changes in groundwater geochemistry accompanying stimulated iron and sulfate reduction and sulfide mineral precipitation. The magnitude of the phase response varied with measurement frequency (0.125 and 1 Hz) and was dependent upon the dominant metabolic process. The spectral effect was corroborated using a biostimulated column experiment containing Rifle sediments and groundwater. Fluids and sediments recovered from regions exhibiting an anomalous phase response were enriched in Fe(II), dissolved sulfide, and cell-associated FeS nanoparticles. The accumulation of mineral precipitates and electroactive ions altered the ability of pore fluids to conduct electrical charge, accounting for the anomalous IP response and revealing the usefulness of multifrequency IP measurements for monitoring mineralogical and geochemical changes accompanying stimulated subsurface bioremediation.

<http://susanhubbard.lbl.gov/pubs/williams-est-rifle-surface.pdf>

### Headspace Single-Drop Microextraction and Cuvetteless Microspectrophotometry for the Selective Determination of Free and Total Cyanide Involving Reaction with Ninhydrin

Jain, A., A.K. Pillai, N. Sharma, and K.K. Verma.

Talanta, Vol 82 No 2, p 758-765, 2010

Headspace single-drop microextraction has been used for the determination of cyanide with ninhydrin in combination with fiber-optic-based cuvetteless microspectrophotometry, which accommodates a sample volume of 1  $\mu$ L placed between the two ends of optical fibers. This

approach, which has been found to avoid salient drawbacks of batch methods, involves hydrocyanic acid formation in a closed vial and simultaneous extraction and reaction with 2  $\mu$ L drop of ninhydrin in carbonate medium suspended at the tip of a microsyringe needle held in the headspace of the acidified sample solution. In tests, the method was linear in range 0.025 to 0.5 mg/L cyanide. The headspace reaction was free from interference. Sulfide was masked by cadmium sulfate, nitrite by sulfamic acid, sulfite by N-ethylmaleimide, and halogens by ascorbic acid. The cyanide limit of detection was found to be 4.3  $\mu$ g/L. This simple method was applied to acid-labile and metal cyanides complexes by treatment with sulfide when metal sulfides were precipitated, setting cyanide ion free. When applied to iron(II) and (III) cyanide complexes by their decomposition with mercury(II), the mercury(II) cyanide formed was then determined. These pre-treatment methods avoided cumbersome pre-separation of cyanide by methods such as distillation or gas diffusion. The overall recovery of cyanide in diverse samples was 97% with RSD of 3.9%

#### Heavy Metal and Trace Metal Analysis in Soil by Sequential Extraction: A Review of Procedures

Zimmerman, A.J. and D.C.Weindorf, Louisiana State Univ., Baton Rouge.

International Journal of Analytical Chemistry, Volume 2010, Article ID 387803, 7 pages, 2010

Quantification of heavy and trace metal contamination in soil can be arduous, requiring the use of lengthy and intricate extraction procedures that may or may not give reliable results. Of the many procedures in publication, some are designed to operate within specific parameters, while others are designed for more broad application. Most procedures have been modified since their inception, which creates ambiguity as to which procedure is most acceptable in a given situation. For this study, the Tessier, Community Bureau of Reference (BCR), Short, Galan, and Geological Society of Canada (GCS) procedures were examined to clarify benefits and limitations of each. Modifications of the Tessier, BCR, and GCS procedures were also examined. The efficacy of these procedures is addressed by looking at the soils used in each procedure, the limitations, applications, and future of sequential extraction.

<http://www.hindawi.com/journals/ijac/2010/387803.html>

#### Heavy Metal Distribution and Chemical Speciation in Tailings and Soils around a Pb-Zn Mine in Spain

Rodriguez, L., E. Ruiz, J. Alonso-Azcarate, and J. Rincon.

Journal of Environmental Management, Vol 90 No 2, p 1106-1116, 2009

Soil pollution by lead, zinc, cadmium, and copper was characterized in the mine tailings and surrounding soils (arable and pasture lands) of an old Spanish Pb-Zn mine. Sixty soil samples were analyzed, determining the total metal concentration by acid digestion and the chemical fractionation of Pb and Zn by a modified BCR sequential extraction method. Samples from the mine waste areas showed the highest values, and high concentrations of Pb, Zn, and Cd found in many of the samples taken from surrounding arable and pasture lands indicated the extent of the dispersion of the heavy metal pollution, likely from acid drainage and wind transport of dust.

High Purge Volume Sampling: A New Paradigm for Subslab Soil Gas Monitoring  
McAlary, T.A., P.J. Nicholson, L.K. Yik, D.M. Bertrand, and G. Thrupp.  
Ground Water Monitoring & Remediation, Vol 30 No 2, p 73-85, 2010

A new method of subslab soil gas monitoring has been developed and tested that is based on a concept of integrating samples over a large volume of soil gas extracted from beneath the floor slab of a building to provide a spatially averaged subslab concentration. Regular field screening is also conducted to assess the trend of concentration as a function of the volume removed to provide insight into the spatial distribution of vapors at progressive distances away from the point of extraction. This approach minimizes the risk of failing to identify the areas of elevated soil vapor concentrations that might exist between discrete sample locations, and can provide information covering large buildings with fewer holes drilled through the floor. The new method also involves monitoring the extraction flow rate and transient vacuum response for mathematical analysis to help interpret the vapor concentration data and support an optimal design if a subslab venting system is needed.

A Highly Selective Lead Sensor Based on a Classic Lead DNAzyme  
Lan, T., K. Furuya, and Y. Lu.  
Chemical Communications, Vol 46 No 22, p 3896-3898, 2010

A catalytic beacon sensor for Pb(2+) has been developed based on the first DNAzyme discovered in the field, and the sensor has shown a much higher metal ion selectivity (40,000 times) than the previously reported Pb(2+) sensor based on 8-17 DNAzyme. It thus is suitable for a wider range of practical applications.

Hybrid Microfluidic Sensors Fabricated by Screen Printing and Injection Molding for Electrochemical and Electrochemiluminescence Detection  
Redha, Z.M., S.J. Baldock, P.R. Fielden, N.J. Goddard, B.J.T. Brown, B.G.D. Haggett, R. Andres, and B.J. Birch.  
Electroanalysis, Vol 21 Nos 3-5, p 422-430, 2009

An integrated microfluidic/electrochemical sensor with a dual working electrode configuration was fabricated for voltammetric and electrochemiluminescence (ECL) applications. The fabrication method integrates the two techniques of injection molding and screen printing for the first time. Injection molding is used to fabricate the flow cell with integrated electrical and fluidic connectors. Screen printing was used to print the electrodes directly onto the injection molded base plate. An over-molding procedure followed by ultrasonic welding was used to form the complete sensor. The electrochemical and ECL performance of the sensors was assessed by applying different electrochemical methods such as cyclic voltammetry (CV), anodic stripping voltammetry (ASV) and chronoamperometry. The attractive analytical performance demonstrates good capability of the disposable sensors for routine on-line electrochemical and ECL measurements.

### Hydrous Manganese Oxide Doped Gel Probe Sampler for Measuring In Situ Reductive Dissolution Rates. 1. Laboratory Development

Farnsworth, C.E. and J.G. Hering, California Inst. of Technology, Pasadena, CA.

Environmental Science & Technology, Vol 44 No 1, p 34-40, 2010

Reductive dissolution of redox-sensitive minerals such as manganese (Mn) oxides in natural sediments is an important mechanism for trace element mobilization into groundwater. A gel probe sampler has been constructed to study in situ reductive dissolution of Mn oxides. The gel consists of a polyacrylamide polymer matrix doped with hydrous Mn oxide (HMO). Gel slabs are mounted into a probe designed to be inserted into the sediments. The amount of Mn released from the gel by reductive dissolution is determined by comparing the amount of Mn initially embedded into the gel with the amount remaining in the gel after exposure to conditions in the sediments or, in laboratory studies, to reducing agents. In this laboratory study, the performance of the gel probes was examined using the model reductant ascorbate and the Mn-reducing bacteria *Shewanella oneidensis* strain MR-1. In addition, a 1-D model was used to relate the reaction rates observed for HMO embedded in gels to those for HMO in suspension. One limitation of the HMO-doped gels for assessing microbial reduction rates is that the gels prevent direct contact between the microbes and the HMO and hence preclude enzymatic reduction at the cell surface; nonetheless, the HMO-doped gel probes potentially can establish a lower bound for Mn-reduction capacity in sediments.

### Hydrous Manganese Oxide Doped Gel Probe Sampler for Measuring In Situ Reductive Dissolution Rates. 2. Field Deployment

Farnsworth, C.E., S.D. Griffis, R.A. Wildman Jr, and J.G. Hering.

Environmental Science & Technology, Vol 44 No 1, p 41-46, 2010

In situ rates of reductive dissolution in submerged shoreline sediments at Lake Tegel (Berlin, Germany) were measured with a novel hydrous manganese (Mn) oxide-doped gel probe sampler in concert with equilibrium gel probe and sequential extraction measurements. Observed rates of reductive dissolution, which reflect a capacity for Mn reduction rather than actual rates under ambient conditions, appear to correlate with porewater chemistry and sequential extraction fractions as expected in early sediment diagenesis, and are consistent with previous measurements of in situ reductive dissolution rates. Significant downward advection in this bank filtration setting depletes the Mn and Fe oxides in the sediments and enhances the transport of dissolved Fe and Mn into the infiltrating water.

### Immobilization of Acetylcholinesterase on Screen-Printed Electrodes. Application to the Determination of Arsenic(III)

Sanllorrente-Mendez, Silvia, Olga Dominguez-Renedo, and M. Julia Arcos-Martínez.

Sensors, Vol 10 No 3, p 2119-2128, 2010

Enzymatic amperometric procedures for measuring arsenic have been developed, based on the inhibitive action of the metal on acetylcholinesterase enzyme activity. Screen-printed carbon electrodes (SPCEs) were used with acetylcholinesterase covalently bonded directly to its surface. The amperometric response of acetylcholinesterase was affected by the presence of arsenic ions, which caused a decrease in the current intensity. The experimental optimum working conditions of pH, substrate concentration and potential applied, were established. Under

these conditions, repeatability and reproducibility of biosensors were determined, reaching values below 4% in terms of relative standard deviation. The detection limit obtained for arsenic was  $1.1 \times 10^{-8}$  M for Ach/SPCE biosensor. Analysis of the possible effect of the presence of foreign ions in the solution was performed, and the method was applied to determine levels of arsenic in spiked tap water samples. <http://www.mdpi.com/1424-8220/10/3/2119/pdf>

Implementation of a Strategic Approach for Complex VI Assessment at a Large Military Facility  
Majcher, E., Geosyntec Consultants.

E2S2 2010: Environment, Energy Security, and Sustainability Symposium and Exhibition, 14-17 June 2010, Denver, Colorado. National Defense Industrial Association (NDIA), Abstract 9772, 21 presentation slides, 2010

Vapor intrusion (VI) assessments are often conducted on a building-by-building basis, with regulatory guidance-specified spacing for sampling of various media (soil gas, sub-slab gas and indoor air) and analytical methods (typically only VOCs). At military installations, large numbers of buildings often comprise a site and more non-standard contaminants of potential concern (COPCs) may be present, including SVOCs, PCBs, pesticides, and chemical warfare agents. A blanket-type sampling and analysis plan (all chemicals in all media at every building) would be prohibitively expensive. This issue arose at the Canal Creek Study Area (CCSA), Aberdeen Proving Ground (APG), MD, which has about 300 buildings and where regulatory negotiations had been stalled for nearly a year. A strategic approach was negotiated to prioritize potential VI risks based on historic soil and groundwater data incorporated into a CSM of the VI pathway. The planned phased approach to VI assessment will serve as a model for other study areas within APG and potentially other DoD facilities. The project will include 1) a project-developed GIS and RDMS based on the knowledge of former chemical use and handling areas and secondary contamination in hydrostratigraphic units with varying depth below land surface; 2) development of site-specific screening levels for the chemicals not normally included in VI assessments; 3) spatial analysis of historic concentrations measured in soil and groundwater compared to the locations of occupied buildings to establish the first phase of field work, which has been limited to a subset of 13 of the 312 buildings believed to pose the greatest VI risk; 4) use of innovative tools, including PDMS samplers (VOCs) and absorbent tubes (non-VOCs) for indoor air, HPV sampling for sub-slab sampling for a very large building, and absorbent tubes for non-VOCs in the subsurface; and 5) regulatory negotiation to secure approval of the prioritization strategy, using the GIS for visuals.

<http://e2s2.ndia.org/schedule/Documents/Abstracts/9772.pdf>

An Inexpensive Multilevel Array of Sensors for Direct Ground Water Velocity Measurement  
Devlin, J.F., G. Tsoflias, M. McGlashan, and P. Schillig.

Ground Water Monitoring & Remediation, Vol 29 No 2, p 73-77, 2009

The point velocity probe (PVP), an instrument capable of measuring groundwater velocity in situ at the centimeter scale, is based on detecting an electrically conductive tracer transported by groundwater around the perimeter of the cylindrical probe. PVPs are easily constructed from inexpensive materials and can be deployed as a single sensor or in multilevel arrays. A multilevel array of these instruments, consisting of four PVPs stacked vertically on each of five stands, was installed as a fence within a sheet-pile alleyway at the Canadian Forces

Base Borden test site in Ontario, Canada. The data from the fence revealed notable velocity variations both spatially and temporally. Groundwater velocity data are likely to be valuable for permeable reactive barrier design and assessment, regulatory compliance assessments, and a variety of research level investigations concerned with local flow phenomena.

#### Interactive Sediment Remedy Assessment Portal (ISRAP)

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools Web site, May 2010

The Interactive Sediment Remedy Assessment Portal (ISRAP) is an online interactive portal designed to assist in understanding monitoring requirements and monitoring tools associated with sediment remediation. The ISRAP can also be useful in understanding data needs during RI/FS, especially as they pertain to remedies themselves, and post-remedy monitoring. The main feature of this site is the sediment monitoring tools matrix, a database of sediment monitoring tool information to facilitate the design and optimization of sediment monitoring programs. The matrix can be browsed in a step-by-step mode. For first-time users, a Frequently Asked Questions (FAQ) link is provided. It contains a tutorial and other resources that give a functional overview of the matrix design and navigation, as well as a short primer to understanding sediment remediation monitoring needs and tools. The Guidance section contains the full, in-depth guidance document (pdf file) that supports the work showcased in the ISRAP. <http://www.ert2.org/ISRAP/>

#### Interrelationship of Pyrogenic Polycyclic Aromatic Hydrocarbon (PAH) Contamination in Different Environmental Media

Kim, Seung-Kyu, Dong Soo Lee, Won Joon Shim, Un Hyuk Yim, and Yong-Seung Shin. Sensors, Vol 9 No 12, p 9582-9602, 2009

Wireless sensor networks equipped with various gas sensors have been actively used for air quality monitoring. Previous studies have typically explored system issues that include middleware or networking performance, but most research has barely considered the details of the hardware and software of the sensor node itself. This paper focuses on the design and implementation of a sensor board for air pollutant monitoring applications. Several hardware and software issues are discussed to explore the possibilities of a practical WSN-based air pollution monitoring system. Through extensive experiments and evaluation, the authors have determined the various characteristics of the gas sensors and their practical implications for air pollutant monitoring systems. <http://www.mdpi.com/1424-8220/9/12/9582/pdf>

#### An Investigation of Aspects of Mine Waste from a Kyanite Mine, Central Virginia, USA

Krekeler, M.P.S., C.S. Allen, L.E. Kearns, and J.B. Maynard. Environmental Earth Sciences, Vol 61 No 1, p 93-106, 2010

As part of the processing at this location, a magnetic separate is generated and a minimum estimation of 3.57 million tons of waste has accumulated at the Kyanite Mining Corporation operation in Dillwyn, VA. In addition to a magnetic separation waste stream, a light blue, water-soluble, amorphous Cu sulfate occurs as a coating on surfaces of boulders. The coating is composed of rounded interlocking particles 5 to 60 um in diameter. This material is of

some environmental concern for freshwater invertebrates, but can be managed using sorption media. Hyperspectral data were gathered of the magnetic separate, kyanite ore samples, and the light blue Cu sulfate. The signatures of the kyanite ore, the blue mineral coating, and a mixture of the two provide spectral fingerprints that an imaging spectrometer could exploit for rapid detection and subsequent environmental monitoring.

ISTA 14: In-Situ Accumulation of PAHs in Low-Density Polyethylene Membranes in Sediment  
Devault, D.A., M. Combe, and C. Gourlay-France.

Environmental Toxicology, 2010 May 20. [Epub ahead of print]

Low-density polyethylene (LDPE) strips were deployed within the 3-cm depth sediment layer of a small river contaminated with PAHs. Over a period of 36 days, the LDPE strips were regularly retrieved and accumulated PAHs were extracted and analyzed. Accumulations were observed for moderately hydrophobic PAHs at high concentrations in the sediment, but the strips showed low accumulations for more hydrophobic compounds, despite their presence in high concentrations in the sediment. This result was explained by very low exchange rates and competitive interactions with particles in the sediment.

Jet A-1, Diesel, and Unleaded Petroleum Plume Separation at a Major Oil Refinery Using Background Fluorescence Analysis Techniques

Otz, M.H. and I. Otz.

IPEC 2009: 16th Annual International Petroleum & Biofuels Environmental Conference, 2-5 November, Albuquerque, New Mexico. Poster, 2009

This poster presents a case study of the separation and delineation of the different organic contaminants of concern (COC) and an evaluation of the efficacy of an existing interceptor trench used for remediation. A hypothesis was tested that the most widely used gasoline products can be traced and separated easily within an affected area using background fluorescence analysis techniques. The fluorescence fingerprints of 300 well waters collected at a major active refinery were compared with each other and also with the characteristic intrinsic fluorescence signature of jet A-1, diesel, and petroleum. These unique fluorescence fingerprints can be used to outline hydraulic connections, differentiate between different plumes, assess the extent of natural attenuation, and qualitatively evaluate dissolved or pure product mixing processes. Moreover, the background fluorescence analysis showed sections where the interceptor trench failed to retain the LNAPLs. [http://ipec.utulsa.edu/Conf2009/Papers%20received/Otz\\_M\\_32.pdf](http://ipec.utulsa.edu/Conf2009/Papers%20received/Otz_M_32.pdf)

A Label-Free Colorimetric Detection of Lead Ions by Controlling the Ligand Shells of Gold Nanoparticles

Hung, Yu-Lun, Tung-Ming Hsiung, Yi-You Chen, and Chih-Ching Huang.

Talanta, Vol 82 No 2, p 516-522, 2010

A simple, colorimetric, and label-free gold nanoparticle (Au NP)-based probe has been developed for the detection of Pb<sup>2+</sup> ions in aqueous solution, operating on the principle that Pb<sup>2+</sup> ions change the ligand shell of thiosulfate (S<sub>2</sub>O<sub>3</sub><sup>2-</sup>)-passivated Au NPs. NPs reacted with S<sub>2</sub>O<sub>3</sub><sup>2-</sup> ions in solution to form Au<sup>+</sup>-S<sub>2</sub>O<sub>3</sub><sup>2-</sup> ligand shells on the Au NP surfaces, thereby inhibiting the access of 4-mercaptobutanol (4-MB). Surface-assisted laser desorption/ionization

time-of-flight ionization mass spectrometry and inductively coupled plasma mass spectrometry measurements revealed that PbAu alloys formed on the surfaces of the Au NPs in the presence of Pb<sup>2+</sup> ions; these alloys weakened the stability of the Au<sup>+</sup>·S<sub>2</sub>O<sub>3</sub><sup>2-</sup> ligand shells, enhancing the access of 4-MB to the Au NP surfaces and inducing their aggregation. As a result, the surface plasmon resonance absorption of the Au NPs red-shifted and broadened, allowing quantitation of the Pb<sup>2+</sup> ions in the aqueous solution. This 4-MB/S<sub>2</sub>O<sub>3</sub><sup>2-</sup>-Au NP probe is highly sensitive (linear detection range: 0.5-10 nM) and selective (by at least 100-fold over other metal ions) toward Pb<sup>2+</sup> ions. This cost-effective sensing system allows the rapid and simple determination of the concentrations of Pb<sup>2+</sup> ions in real samples (in this case, river water, Montana soil, and urine).

#### Laser Spectroscopy for Atmospheric and Environmental Sensing

Fiddler, M.N., I. Begashaw, M.A. Mickens, M.S. Collingwood, Z. Assefa, and S. Bililign. *Sensors*, Vol 9 No 12, p 10447-10512, 2009

This review is focused on three areas of laser spectroscopic applications in atmospheric and environmental sensing: laser-induced fluorescence (LIF), cavity ring-down spectroscopy (CRDS), and photoluminescence techniques used in the detection of solids, liquids, aerosols, trace gases, and VOCs. <http://www.mdpi.com/1424-8220/9/12/10447/pdf>

#### Lysozyme-Stabilized Gold Fluorescent Cluster: Synthesis and Application As Hg(2+) Sensor

Wei, H., Z. Wang, L. Yang, S. Tian, C. Hou, and Y. Lu.

*Analyst*, Vol 135 No 6, p 1406-1410, June 2010

Highly fluorescent gold clusters have been synthesized in basic aqueous solution by using lysozyme as reducing and stabilizing agents. The lysozyme-stabilized gold fluorescent clusters (LsGFC) have an average size of 1 nm and emission of ~657 nm. The fluorescence could be specifically quenched by Hg(2+), so the LsGFC can be used as a sensor for sensitive and selective Hg(2+) detection with a detection limit of 10 nM.

#### Macro- and Micro-Purge Soil-Gas Sampling Methods for the Collection of Contaminant Vapors

Schumacher, B.A., J.H. Zimmerman, C.R. Sibert, K.E. Varner, and L.A. Riddick.

*Ground Water Monitoring & Remediation*, Vol 29 No 1, p 138-143, 2009

Purging influence on soil-gas concentrations for VOCs, as affected by sampling tube inner diameter and sampling depth (i.e., system volume) for temporary probes in fine-grained soils, was evaluated at three different field sites. A macro-purge sampling system consisted of a standard, hollow, 3.2-cm outer diameter (OD) drive probe with a retractable sampling point attached to an appropriate length of 0.48-cm inner diameter (ID) Teflon(r) tubing. The macro-purge sampling system had a purge system volume of 24.5 mL at a 1-m depth. In contrast, the micro-purge sampling systems were slightly different between the field sites and consisted of a 1.27-cm OD drive rod with a 0.10-cm ID stainless steel tube or a 3.2-cm OD drive rod with a 0.0254-cm inner diameter stainless steel tubing resulting in purge system volumes of 1.2 and 7.05 mL at 1-m depths, respectively. At each test area, with a few exceptions, the same contaminants were identified in the same relative order of abundances, indicating the sampling of the same general soil atmosphere, but marked differences in VOC concentrations were identified between the sampling systems. Micro-purge samples had up to 27 times higher concentrations

than their corresponding macro-purge samples. The higher concentrations are the result of a minimal disturbance of the ambient soil atmosphere during purging, which allowed for the collection of a sample that is more representative of the soil atmosphere surrounding the sampling point. The authors recommend that when soil-gas sampling is conducted using temporary probes in fine-grained soils, the sampling system should use the smallest practical ID soil-gas tubing and minimize purge volume to obtain soil-gas samples with more representative soil-gas concentrations.

#### Metal Oxide Semi-Conductor Gas Sensors in Environmental Monitoring

Fine, G.F., L.M. Cavanagh, A. Afonja, and R. Binions.

Sensors, Vol 10 No 6, p 5469-5502, 2010

Metal oxide semiconductor gas sensors are utilized in a variety of different roles and industries. They are relatively inexpensive compared to other sensing technologies, robust, lightweight, long lasting and benefit from high material sensitivity and quick response times. They have been used extensively to measure and monitor trace amounts of environmentally important gases such as carbon monoxide and nitrogen dioxide. This review explores the nature of the gas response and how it is fundamentally linked to surface structure. Synthetic routes to metal oxide semiconductor gas sensors are also discussed and related to their effect on surface structure. An overview of important contributions and recent advances are discussed for the use of metal oxide semiconductor sensors for the detection of a variety of gases: CO, NO<sub>x</sub>, NH<sub>3</sub>, and the particularly challenging CO<sub>2</sub>. A description of recent advances in work completed at University College London includes the use of selective zeolites layers, new perovskite type materials, and an innovative chemical vapor deposition approach to film deposition.

<http://www.mdpi.com/1424-8220/10/6/5469/pdf>

#### Method 9016: Free Cyanide in Water, Soils and Solid Wastes by Microdiffusion

U.S. EPA, SW-846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 30 pp, June 2010

This test method covers the determination of free cyanide in waste waters, ground waters, surface waters, drinking waters, soils, and solid wastes. This test method reports the cyanide that dissociates from simple cyanides or weakly-bound metal cyanide complexes at room temperature, from a solution of pH 6-6.5. CN<sup>-</sup> (CAS 57-12-5) has been determined by this method. This method does not determine strongly-bound metal cyanide complexes that resist dissociation, such as the hexacyanoferrates and gold cyanide, nor does it determine thiocyanate and cyanohydrin. <http://www.epa.gov/wastes/hazard/testmethods/pdfs/9016.pdf>

#### Micro Sensor Node for Air Pollutant Monitoring: Hardware and Software Issues

Choi, Sukwon, Nakyoung Kim, Hojung Cha, and Rhan Ha.

Sensors, Vol 9 No 10, p 7970-7987, 2009

Wireless sensor networks equipped with various gas sensors have been actively used for air quality monitoring. Previous studies have typically explored system issues that include middleware or networking performance, but most research has barely considered the details of the hardware and software of the sensor node itself. This paper focuses on the design and

implementation of a sensor board for air pollutant monitoring applications. Several hardware and software issues are discussed to explore the possibilities of a practical WSN-based air pollution monitoring system. Through extensive experiments and evaluation, the authors have determined the various characteristics of the gas sensors and their practical implications for air pollutant monitoring systems. <http://www.mdpi.com/1424-8220/9/10/7970/pdf>

Micro- and Mini-Nitrate Sensors for Monitoring of Soils, Groundwater and Aquatic Systems  
Ratako, A., H. Dietrich, Y. Park, R. Gonzalez-Jimenez, D. Kim, B. Aswin, I.B. Goldberg, T.C. Harmon, and J.W. Judy.

University of California, Center for Embedded Network Sensing, Poster, 2009

Sensor researchers have been working toward high-performance scalable nitrate sensors using potentiometric, amperometric, and spectrochemical methods. This poster describes the fabrication and testing of the prototype sensors.

<http://escholarship.org/uc/item/7td3g73w>

Microcosm Assessment of a DNA Probe Applied to Aerobic Degradation of cis-1,2-Dichloroethene by *Polaromonas* sp. Strain JS666

Giddings, C.G.S., L.K. Jennings, and J.M. Gossett.

Ground Water Monitoring & Remediation, Vol 30 No 2, p 97-105, 2010

This paper describes the development and evaluation of a DNA probe for *Polaromonas* sp. strain JS666, a bacterium that couples growth to aerobic oxidation of cis-1,2-dichloroethene (cDCE), and is therefore a promising candidate for bioaugmentation at sites where cDCE has accumulated in aerobic zones. The DNA probe was used in conjunction with quantitative polymerase chain reaction to track the abundance of JS666 in microcosms. These studies have allowed explicit resolution of the accuracy and precision of the probe and its correlation with variations in microcosm performance, indicating that the method is sufficient to monitor distribution of JS666 at bioaugmented sites. The DNA target does not persist long after cell death within environmental, mixed cultures, demonstrating that positive result from the probe is a strong indicator that degradation can occur in suitable environmental conditions. Altogether, the studies appear to validate the utility of the molecular probe for site assessment relevant to bioaugmentation.

Micron-Scale Sensors for Spatiotemporal Study of Water Photodecontamination

Scheeline, A. and R.C Wilson, Univ. of Illinois at Urbana-Champaign.

Symposium Q: Materials Science of Water Purification, 14-16 April 2009. Materials Research Society, Warrendale, PA. MRS Symposium Proceedings Vol 1169E, paper Q5.7, 2009

Photocatalytic oxidation of water contaminants can proceed in at least two ways: by adsorption and activation of contaminants on photocatalysts (followed by reaction with dissolved oxygen after desorption) or by homogeneous oxidation by reactive oxygen species generated by the photocatalyst. Distinguishing these two mechanisms is feasible if concentration of H<sub>2</sub>O<sub>2</sub> and superoxide radical can be spatially measured in thin aqueous layers near the catalysts. The authors report development of 3-electrode amperometric microsensors ~200 μm wide and characterize their response to the species of interest and interferents.

### Mobile Sensor Networks for Inspection Tasks in Harsh Industrial Environments

Mulder, J., X. Wang, F. Ferwerda, and M. Cao.

Sensors, Vol 10 No 3, 1599-1618, 2010

Recent advances in sensor technology have enabled the fast development of mobile sensor networks operating in a variety of unknown and sometimes hazardous environments. This paper introduces an integrative approach to design, analyze, and test distributed-control algorithms to coordinate a network of autonomous mobile sensors by utilizing both simulation tools and a robotic testbed. The research has been carried out in the context of the mobile sensing project, PicoSmart, in the northern provinces of the Netherlands for the inspection of natural gas pipelines. <http://www.mdpi.com/1424-8220/10/3/1599/pdf>

### Model Stream Channel Testing of a UV-Transparent Polymer-Based Passive Sampler for Ultra-Low-Cost Water Screening Applications

Kibbey, T.C., L. Chen, D.A. Sabatini, M.A. Mills, and C. Nietch.

Chemosphere, 2010 Jul 2 [Epub ahead of print.]

A recently developed passive sampling device is designed to provide an ultra-low-cost screening method for organic chemicals in waters. Originally designed for detection of endocrine-disrupting chemicals, the device is capable of simultaneously detecting a wide range of other aqueous organic contaminants. The device is based on a UV-transparent polymer that is used both to concentrate dissolved chemicals and as an optical cell for absorbance detection and full-spectrum deconvolution to identify compounds. This paper describes the results of a test of the device conducted at the U.S. EPA Experimental Stream Facility in Milford, Ohio. The test examined detection of triclosan and 4-nonylphenol in model stream channels using two different deployment methods. Results indicate that deployment method can impact measured results significantly due to differences in mass transfer. Passive samplers deployed in vials with permeable membrane septa showed no detection of either compound, likely due to lack of water motion in the vials. In contrast, passive samplers deployed directly in the flow were able to track concentrations of both compounds and respond to temporal changes in concentration. The results highlight the importance of using internal spiking standards (performance reference compounds) to avoid false non-detection results in passive sampler applications.

### Molecular Analysis of Phosphate Limitation in *Geobacteraceae* during the Bioremediation of a Uranium-Contaminated Aquifer

N'Guessan, A.L., H. Elifantz, K.P. Nevin, P.J. Mouser, B. Methe, T.L. Woodard, K. Manley, K.H. Williams, M.J. Wilkins, J.T. Larsen, P.E. Long, and D.R. Lovley.

LBNL-2720E, 40 pp, Sep 2009 [Published in The ISME Journal, Vol 4, p 253-266, Feb 2010]

Nutrient limitation can reduce the effectiveness of bioremediation strategies, especially when the contaminants are organic compounds or when organic compounds are added to promote microbial activities, such as metal reduction. Genes indicative of phosphate limitation were identified via microarray analysis of chemostat cultures of *Geobacter sulfurreducens*. This analysis revealed that genes in the *pst-pho* operon, which is associated with a high-affinity phosphate uptake system in other microorganisms, had significantly higher transcript abundance under phosphate-limiting conditions, with the genes *pstB* and *phoU* the most up-regulated.

Quantitative PCR analysis of *pstB* and *phoU* transcript levels in *G. sulfurreducens* grown in chemostats demonstrated that the expression of these genes increased when phosphate was removed from the culture medium. Transcripts of *pstB* and *phoU* within the subsurface *Geobacter* species predominating during an in situ uranium bioremediation field experiment were more abundant than in chemostat cultures of *G. sulfurreducens* that were not limited for phosphate. Addition of phosphate to incubations of subsurface sediments did not stimulate dissimilatory metal reduction. The added phosphate was rapidly adsorbed onto the sediments. The results demonstrate that *Geobacter* species can reduce U(VI) effectively even when experiencing suboptimal phosphate concentrations and that increasing phosphate availability with phosphate additions is difficult to achieve due to the high reactivity of this compound. This transcript-based approach developed for diagnosing phosphate limitation should be applicable to assessing the potential need for additional phosphate in other bioremediation processes.

<http://www.osti.gov/bridge/purl.cover.jsp?purl=/974274-yx3g6m/>

#### Monitoring Gene Expression to Evaluate the Effectiveness of Oxygen Infusion at a Gasoline-Impacted Site

Baldwin, B., D. Ogles, G. Davis, J. Blair, M. Purchase, and J.M. Baker.

IPEC 2009: 16th Annual International Petroleum & Biofuels Environmental Conference, 2-5 November, Albuquerque, New Mexico. Abstract only, 2009

Evaluation of corrective actions designed to enhance biodegradation of petroleum hydrocarbons and fuel oxygenates should include chemical, geochemical, and microbiological lines of evidence. At gasoline-impacted sites, temporal monitoring and analysis of trends in dissolved BTEX and MTBE concentrations can be used to document contaminant loss and provide the first line of evidence. Likewise, temporal monitoring of geochemical parameters can reveal changes in redox status resulting from site activities and changes in electron acceptor availability, and can provide a second indicator of enhanced biodegradation. The third and potentially most direct line of evidence used to evaluate the ability of a remediation technology to stimulate biodegradation is to quantify expression of the genes and activity of the organisms responsible for contaminant biodegradation. Quantitative polymerase chain reaction (qPCR) and reverse-transcription qPCR (RT-qPCR) were used to monitor microbial populations and gene expression to evaluate the effectiveness of an oxygen infusion system to promote aerobic biodegradation of BTEX and MTBE. During system startup and continuous operation, dissolved oxygen (DO) levels at the injection points were greater than 30 mg/L, contaminant concentrations decreased, and transcription of aromatic oxygenase genes (toluene dioxygenase and phenol hydroxylase) and activity of MTBE-utilizing strain *Methylisium petroleiphilum* PM1 increased by as many as four orders of magnitude in response to system operation. Moreover, aromatic oxygenase gene transcription and PM1 activity increased at downgradient locations despite the fact that DO levels in downgradient wells did not increase appreciably during system operation. Conversely, BTEX- and MTBE-utilizing populations, aromatic oxygenase gene transcription, and PM1 activity decreased substantially when the system was temporarily deactivated. Overall, traditional groundwater analyses combined with monitoring gene expression provided the three lines of evidence needed to demonstrate conclusively that the oxygen infusion system effectively promoted BTEX and MTBE biodegradation at the site.

### Monitoring Microbial Community Structure and Dynamics during In Situ U(VI) Bioremediation with a Field-Portable Microarray Analysis System

Chandler, D.P., A. Kukhtin, R. Mokhiber, C. Knickerbocker, D. Ogles, G. Rudy, J. Golova, P. Long, and A. Peacock.

Environmental Science & Technology, 2010 Jun 18. [Epub ahead of print]

A simple, field-portable, microarray system for monitoring microbial community structure and dynamics in groundwater and subsurface environments was developed and validated using samples representing site status before acetate injection, during Fe-reduction in the transition from Fe- to SO<sub>4</sub>(2<sup>-</sup>)-reduction, and into the SO<sub>4</sub>(2<sup>-</sup>)-reduction phase. Limits of detection for the array are ~10<sup>2</sup> to 10<sup>3</sup> cell equivalents of DNA per reaction. Sample-to-answer results for the field deployment were obtained in 4 h. Retrospective analysis of 50 samples showed the expected progression of microbial signatures from Fe- to SO<sub>4</sub>(2<sup>-</sup>)-reducers with changes in acetate amendment and in situ field conditions. The microarray response for *Geobacter* was highly correlated with qPCR for the same target gene ( $R^2 = 0.84$ ). Microarray results were in concordance with quantitative PCR data, aqueous chemistry, site lithology, and the expected microbial community response, indicating that the field-portable microarray is an accurate indicator of microbial presence and response to in situ remediation of a uranium-contaminated site.

### A Nanopore Structured High Performance Toluene Gas Sensor Made by Nanoimprinting Method

Kim, K.-S., W.-H. Baek, J.-M. Kim, T.-S. Yoon, H.H. Lee, C.J. Kang, and Y.-S. Kim. Sensors, Vol 10 No 1, p 765-774, 2010

Toluene gas was measured at room temperature using a device microfabricated by a nano-imprinting method. A highly uniform nanoporous thin film was produced with a dense array of titania (TiO<sub>2</sub>) pores with a diameter of 70~80 nm using this method. This thin film had a Pd/TiO<sub>2</sub> nanoporous/SiO<sub>2</sub>/Si MIS layered structure with Pd-TiO<sub>2</sub> as the catalytic sensing layer. The nanoimprinting method was useful in expanding the TiO<sub>2</sub> surface area by about 30%, as confirmed using AFM and SEM imaging. The measured toluene concentrations ranged from 50 ppm to 200 ppm. The toluene was easily detected by changing the Pd/TiO<sub>2</sub> interface work function, resulting in a change in the I-V characteristics.

<http://www.mdpi.com/1424-8220/10/1/765/pdf>

### New Approach for Measuring Denitrification in the Rhizosphere of Vegetated Marsh Sediments

Koop-Jakobsen, K. and A.E. Giblin. Limnology and Oceanography Methods, Vol 7 No 9, p 626-637, 2009

A new approach for measuring denitrification at depth in the marsh rhizosphere (below 5 cm). combines the push-pull technique and the <sup>15</sup>N-isotope pairing technique, referred to here as the PPIPT. The PPIPT allows ambient denitrification rates to be measured in situ at depth in the marsh rhizosphere with minimal damage to roots and rhizomes and minimal disturbance of the ambient pore water composition. In this method, pore water is extracted from the sediment using micropiezometers without contact with the atmosphere. The porewater is amended with <sup>15</sup>NO<sub>3</sub><sup>-</sup> to trace denitrification, and Ar(g) is added to trace potential gas loss of denitrification end products. The "spiked" pore water is injected back into the sediment for incubation.

Subsequently, sequential samples are extracted from the sediment for analysis of  $^{28}\text{N}_2$ ,  $^{29}\text{N}_2$ ,  $^{30}\text{N}_2$ , and Ar. Denitrification rates are calculated using the isotope pairing technique and corrected for dilution and gaseous losses using the argon tracer. After lab and field tests were conducted to optimize the method, the PPIPT was applied in the field to measure denitrification in the rhizosphere of various vegetation zones in two New England marshes. The field applications verified the PPIPT method as a useful tool for measuring ambient rates of denitrification at depth in salt marsh rhizospheres. Generally, the rates measured were low (0 to 12  $\mu\text{mol m}^2/\text{h}$ ) and showed a high spatial variability in the marsh rhizosphere among different vegetation zones.

#### New Catalytic DNA Fluorescent and Colorimetric Sensors for On-Site and Real-Time Monitoring of Industrial and Drinking Water

Lu, Y., Univ. of Illinois at Urbana-Champaign.

Illinois Sustainable Technology Center RR-114, 40 pp, Feb 2009

Researchers at the University of Illinois at Urbana-Champaign have developed new fluorescent and colorimetric sensor technologies for on-site, real-time detection and quantification of toxic metal ions such as lead, mercury, and uranium in industrial and drinking waters. A combinatorial biology method called in vitro selection was used to obtain catalytic DNA with high specificity and selectivity for the metal ions. By labeling the DNA with either fluorophore/quencher pairs or gold nanoparticles, the catalytic DNA has been transformed into a highly sensitive and selective fluorescent or colorimetric biosensor, respectively. The presence of metal ions causes the catalytic DNA to cleave, resulting in either a dramatic increase of fluorescent signals or a distinctive change of colors. The sensors are highly sensitive (with detection limit as low as 11 ppt) and selective (with selectivity of over million fold). The catalytic DNA fluorescent biosensors make it possible to analyze metal ions using simple portable fluorimeters, and the catalytic DNA colorimetric biosensors can eliminate equipment altogether. This is possible because the toxic metal ions can be detected through simple color changes, just like pH paper. [http://www.istc.illinois.edu/info/library\\_docs/RR/RR-114.pdf](http://www.istc.illinois.edu/info/library_docs/RR/RR-114.pdf)

#### A Nitrite Biosensor Based on Co-Immobilization of Nitrite Reductase and Viologen-Modified Chitosan on a Glassy Carbon Electrode

Quan, D. and W. Shin.

Sensors, Vol 10 No 6, p 6241-6256, 2010

An electrochemical biosensor for the environmental pollutant nitrite is based on co-immobilization of copper-containing nitrite reductase (Cu-NiR, from *Rhodospseudomonas sphaeroides* forma sp. denitrificans) and viologen-modified chitosan (CHIT-V) on a glassy carbon electrode (GCE). Electron transfer (ET) between a conventional GCE and immobilized Cu-NiR was mediated by the co-immobilized CHIT-V. Redox-active viologen was covalently linked to a chitosan backbone, and the thus-produced CHIT-V was co-immobilized with Cu-NiR on the GCE surface by drop-coating of hydrophilic polyurethane (HPU). The electrode responded to nitrite with a limit of detection of 40 nM (S/N = 3). The sensitivity, linear response range, and response time ( $t_{90\%}$ ) were 14.9 nA/mM, 0.04-11 mM ( $r^2 = 0.999$ ), and 15 s, respectively. The corresponding Lineweaver-Burk plot showed that the apparent Michaelis-Menten constant ( $K_{Mapp}$ ) was 65 mM. Storage stability of the biosensor (retaining 80% of

initial activity) was 65 days under ambient air and room temperature storage conditions. Reproducibility of the sensor showed a relative standard deviation (RSD) of 2.8% (n = 5) for detection of 1 mM of nitrite. An interference study showed that anions commonly found in water samples, such as chlorate, chloride, sulfate, and sulfite, did not interfere with the nitrite detection; however, nitrate interfered with a relative sensitivity of 64%, and this interference effect was due to the intrinsic character of the NiR employed in this study.  
<http://www.mdpi.com/1424-8220/10/6/6241/pdf>

#### A Novel Cyanide Ion Sensing Approach Based on Raman Scattering for the Detection of Environmental Cyanides

Yan, F., C.V. Gopal Reddy, Y. Zhang, and T. Vo-Dinh.

Ecotoxicology and Environmental Safety, 2010 Jun 9. [Epub ahead of print]

This paper describes a direct optical approach based on Raman scattering for selective and sensitive detection of cyanide ions in aqueous environment without requiring time-consuming sample pretreatment and the formation of hydrogen cyanide. Due to the strong affinity between copper (I) and cyanide ion, evaporated copper (I) iodide (CuI) thin films are shown to be excellent substrates for selective recognition of free cyanide ions in aqueous matrices. The amount of cyanide ion retained by the copper (I) in the CuI thin films reflects its actual concentration in tested samples, and the subsequent Raman measurements of the substrate can detecting toxic cyanide content below regulatory concentrations. Measurements obtained from the same batch of evaporated CuI thin films (~100-nm thickness) show excellent linearity over a variety of cyanide concentrations ranging from 1.5  $\mu$ M to 0.15 mM. This detection method offers the advantage of selectively detecting cyanides while avoiding detection of other common interfering anions. Coupled with commercially available portable Raman systems, this detection approach will provide on-site monitoring capability with little sample preparation or instrument supervision.

#### A Novel Miniaturized Homogenous Liquid-Liquid Solvent Extraction-High Performance Liquid Chromatographic-Fluorescence Method for Determination of Ultra Traces of Polycyclic Aromatic Hydrocarbons in Sediment Samples

Shamsipur, M. and J. Hassan.

Journal of Chromatography A, Vol 1217 No 30, p 4877-4882, 2010

A novel technique called miniaturized homogeneous liquid-liquid extraction (MHLLE) followed by high performance liquid chromatographic-fluorescence detection (HPLC-FL) was developed for the extraction and determination of PAHs as a model analytical problem in sediment samples. The method is based on the rapid extraction of PAHs from a methanolic sample solution into 0.5 mL n-hexane, as a solvent of lower density than water. After addition of water, the extracting solvent immediately forms a distinct water-immiscible phase at the top of the vial, which can be easily separated, evaporated and re-dissolved in 25  $\mu$ L of methanol and injected to the HPLC instrument. The parameters affecting the extraction process, such as type and volume of organic extraction solvent, extraction time, and salt addition, were investigated and the partition coefficient between methanol/water-n-hexane phases was evaluated and used to predict the extraction efficiency. Under optimal conditions, the limits of detection were estimated for the individual PAHs as 3 times of the standard deviation of baseline of the measured chromatogram, in the range of 0.003 to 0.04 ng/g for sediment samples. The relative recoveries

of PAHs at spiking levels of 1.0 ng/g for sediment samples were in the range of 81 to 92%. The method was also applied to corresponding standard reference materials (IAEA-408) successfully. The proposed method is very fast, simple, and sensitive without any need for stirring and centrifugation.

#### An Overview and Comparison of Methods for Cyanide Analysis

Lipps, W., OI Analytical.

NEMC 2009: The 25th Annual National Environmental Monitoring Conference, 22 presentation slides, 2009

As a generalization, all cyanide (CN) methods generate HCN from a sample matrix in which the method parameters define the CN species. HCN is separated by manual distillation, automated distillation, or gas diffusion to measure CN. This presentation provides a brief overview of available cyanide methods, compares methods for measuring available cyanide, discusses total cyanide methods using manual distillation and automated total cyanide methods using UV to liberate HCN from Fe, and compares results achieved by different methods.

[http://www.nemc.us/nemc09\\_presents/Presentation-Cyanide-WilliamLipps-8-13-09.pdf](http://www.nemc.us/nemc09_presents/Presentation-Cyanide-WilliamLipps-8-13-09.pdf)

#### A Passive Sampler Based on Solid-Phase Microextraction for Quantifying Hydrophobic Organic Contaminants in Sediment Pore Water

Maruya, K.A., E.Y. Zeng, D. Tsukada, and S.M. Bay.

Environmental Toxicology and Chemistry, Vol 28 No 4, p 733-740, 2009

The bulk sediment toxicant concentration, the most widely used chemical parameter, does not always represent the bioavailable concentration, particularly for hydrophobic organic compounds (HOCs) in highly contaminated sediments. The authors developed and tested a porewater sampler that uses solid-phase microextraction (SPME) to measure freely dissolved (bioavailable) HOC concentrations. A single polydimethylsiloxane (PDMS)-coated SPME fiber is secured in a compact, protective housing that allows aqueous exchange with whole sediment while eliminating direct contact with sediment particles. Fibers with three PDMS coating thicknesses were first calibrated for 12 model HOCs of regulatory concern. Precalibrated samplers were exposed to spiked estuarine sediment in laboratory microcosms to determine the time to equilibrium and the equilibrium concentrations across a range of sediment contamination. Time to equilibrium ranged from 14 to 110 d, with 30 d being sufficient for more than half the target HOCs. Equilibrium SPME measurements, ranging from 0.009 to 2,400 ng/L, were highly correlated with but generally lower than HOC porewater concentrations determined independently by liquid-liquid extraction. This concept shows promise for directly measuring the freely dissolved concentration of HOCs in sediment porewater, previously a difficult-to-measure parameter that will improve the ability to assess the impacts of contaminated sediments.

#### Passive Samplers for Monitoring VOCs in Groundwater and the Prospects Related to Mass Flux Measurements

Verreydt, G., J. Bronders, I. Van Keer, L. Diels, and P. Vanderauwera.

Ground Water Monitoring & Remediation, Vol 30 No 2, p 114-126, 2010

A review of current passive samplers for the measurement of organic contaminants in water yielded 18 samplers, which were screened for various criteria related to the possible application of the sampler for the measurement of VOC mass fluxes in groundwater. This

screening study indicates that direct measurement of VOC mass fluxes in groundwater is possible with very few passive samplers. Currently, the passive flux meter is the only passive sampler that has proven to measure mass fluxes effectively in near source groundwater. A passive sampler suitable for long-term monitoring (several months to a year) of mass flux measurement in plume zones has yet to be developed or optimized.

#### Performance Assessment of Bioremediation and Natural Attenuation

Illman, W. and P.J.J. Alvarez.

Critical Reviews in Environmental Science and Technology, Vol 39 No 4, p 209-270, 2009

Bioremediation and monitored natural attenuation are among the most cost-effective approaches to manage soil and groundwater contamination by hazardous organic pollutants; however, these remediation alternatives are not universally applicable and may be marginally effective for recalcitrant pollutants if the necessary microbial catabolic capacity is not present or expressed. Regulatory approval of bioremediation and natural attenuation requires documentation of the efficacy of microbial degradation of the target pollutants. Performance assessment generally consists of three components: documented contaminant mass loss, geochemical fingerprints associated with biodegradation, and microcosm studies that show direct evidence of biodegradation. More recently, new molecular and isotope fractionation techniques have emerged to complement existing technologies for the forensic analysis and the demonstration of bioremediation and natural attenuation. This critical review examines the current state of art in performance assessment methods and discusses future research directions. <http://cohesion.rice.edu/engineering/pedroalvarez/emplibrary/101.pdf>

#### Portable Rapid Test Fuel Tank Leak Detection System

Major, W. and L. Karr.

Technical Memorandum

TM-2412-ENV 86 pp, Apr 2010

The Portable Rapid Test (PRT) tank leak detection system development aims to bring Navy fuel tanks into regulatory compliance in a cost-effective manner. The PRT Leak Detection System was successfully designed and evaluated for use in 50,000 gallon fuel underground storage tanks (USTs). Using EPA-mandated procedures, the PRT achieved a 0.067 gal/hr leak rate with 95% probability of detection (PD) and 5% probability of false alarm (PFA) during third party certification testing at the Barking Sands Pacific Missile Range fuel farm, Kauai, Hawaii. This is the best EPA-approved leak rate achieved to date in industry worldwide for a 50,000 gallon in-tank system, with results in 5 hours, and is the only available system with dual capability for conducting a combined monthly and annual compliance test. The system allows testing at EPA standard leak rates of 0.10 gal/hr and 0.20 gal/hr with a very high PD and very low PFA. This provides a significant improvement over current methods technologically, operationally, and in short- and long-term cost benefits. The final report steps through the development stages of the PRT technology: off-the-shelf component elections, development of new hardware and software, system integration, and laboratory, field, and certification testing. <http://handle.dtic.mil/100.2/ADA519556>

## Proactive Screening Approach for Detecting Groundwater Contaminants along Urban Streams at the Reach-Scale

Roy, J.W. and G. Bickerton, National Water Research Institute, Environment Canada. Environmental Science & Technology, 2010 Jul 9. [Epub ahead of print]

The authors outline and demonstrate a screening approach for the detection of groundwater contaminants along urban streams within unconsolidated beds. It involves the rapid acquisition of groundwater samples along urban stream reaches at a spacing of about 10 m and from depths of about 25 to 75 cm below the streambed, with analyses for a suite of potential contaminants. This screening approach can detect and identify groundwater contamination in urban settings rapidly and inexpensively compared to land-based well installations. The screening approach was tested at three urban streams, each affected by a known, roughly delineated chlorinated-solvent plume. Multiple, previously unknown areas or types of groundwater contamination were also identified at each stream. The newly identified contaminants and plumes included petroleum hydrocarbons (BTEX, naphthalene, MTBE), 1,4-dioxane, nitrate and phosphate, road salt, and various metals (arsenic, cadmium, chromium, copper, lead) at elevated concentrations compared to background values and relevant Canadian water quality guidelines.

## Probing the Biogeochemical Behavior of Technetium Using a Novel Nuclear Imaging Approach

Lear, G., J.M. McBeth, C. Boothman, D.J. Gunning, B.L. Ellis, R.S. Lawson, K. Morris, I.T. Burke, N.D. Bryan, A.P. Brown, F.R. Livens, and J.R. Lloyd. Environmental Science & Technology, Vol 44 No 1, p 156-162, 2010

Medical equipment used for diagnosis of patients with heart disease and cancer could be a key weapon in stopping the migration of nuclear waste in the environment, according to new research results. A team of scientists from the Universities of Manchester and Leeds has joined forces with experts in nuclear medicine at Manchester Royal Infirmary, using medical gamma-ray cameras to track radioactive isotopes in soil samples. The tracking agent is a short-lived medical isotope of technetium (Tc) used routinely as a medical tracer in human bodies. Researchers from the University of Manchester, led by Professor Jon Lloyd, took soil samples from an Oak Ridge nuclear facility in the United States and successfully tracked the movement of medical Tc through the soil. Scientists at The University of Leeds then verified the observations using transmission electron microscopy. With the help of DNA analysis, the Manchester team confirmed that certain microbes--particularly some that use ferric iron for energy--can fix Tc in place in soil. Researchers found that nearly all the Tc remained fixed when ferric iron was present with certain iron-reducing bacteria. This finding itself is not new; Professor Lloyd and his colleagues had previously reported that microbes in laboratory cultures could perform this role in fixing Tc. But the researchers' success with the gamma camera could see future use of the technique in probing how Tc and ferric iron move together in complex soil systems and help to develop future remediation techniques.

Proteogenomic Monitoring of Geobacter Physiology during Stimulated Uranium Bioremediation  
Wilkins, M.J., N.C. Verberkmoes, K.H. Williams, S.J. Callister, P.J. Mouser, H. Elifantz, A.L. N'guessan, B.C. Thomas, C.D. Nicora, M.B. Shah, P. Abraham, M.S. Lipton, D.R. Lovley, R.L. Hettich, P.E. Long, and J.F. Banfield.

Applied and Environmental Microbiology, Vol 75 No 20, p 6591-6599, 2009

Bioremediation of uranium contamination in groundwater requires methods for monitoring the membership and activities of the subsurface microbial communities that are responsible for reduction of soluble U(VI) to insoluble U(IV). This paper reports a proteomics-based approach for simultaneously documenting the strain membership and microbial physiology of the dominant Geobacter community members during in situ acetate amendment of the U-contaminated aquifer at Rifle, CO. Three planktonic Geobacter-dominated samples were obtained from two wells down-gradient of acetate addition. Over 2,500 proteins from each of these samples were identified by matching liquid chromatography-tandem mass spectrometry spectra to peptides predicted from seven isolate Geobacter genomes. Throughout biostimulation, the proteome is dominated by enzymes that convert acetate to acetyl-coenzyme A and pyruvate for central metabolism, while abundant peptides matching tricarboxylic acid cycle proteins and ATP synthase subunits were also detected, indicating the importance of energy generation during the period of rapid growth following the start of biostimulation. Evolving Geobacter strain composition might be linked to changes in protein abundance over the course of biostimulation and possibly reflect changes in metabolic functioning. Thus, metagenomics-independent community proteogenomics can be used to diagnose the status of the subsurface consortia upon which remediation biotechnology relies.

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2765142/pdf/1064-09.pdf>

Quantitative Passive Diffusive-Adsorptive Sampling Techniques for Vapor Intrusion Assessment  
Groenevelt, H., T. McAlary, T. Gorecki, S. Seethapathy, P. Sacco, D. Crump, M. Taday, B. Schumacher, H. Hayes, and P. Johnson.

EMDQ 2010: DoD Environmental Monitoring and Data Quality Workshop, 12-16 April 2010, Louisville, Kentucky. 32 presentation slides, 2010

This presentation summarizes results of ESTCP-funded lab and field tests of four competing technologies--Radiello(tm), SKC Ultra II(tm), Waterloo Membrane Samplers, and Perkin Elmer tube samplers--for quantitative passive sampling and analysis of VOCs in indoor air and soil gas during vapor intrusion assessments. Conventional sampling in Summa canisters with laboratory analysis by EPA Method TO-15 typically costs \$250 to \$400 per sample and is labor-intensive. Passive diffusive sampling and analysis can be 30 to 50% less expensive and have at least 5 technical benefits: 1) consistent use by different operators with minimal training, 2) deployment over relatively long periods of time, providing a long-term average concentration more suitable for assessing long-term risks and minimizing temporal variability inherent in shorter-term samples, 3) low reporting limits with no increase in cost of analysis, 4) potential to include SVOCs and heavier organic compounds on the analyte list without the costs of multiple analytical methods, and 5) small size less disruptive to building occupants, with simpler shipping and handling. Each sampler contains adsorbent media that trap VOCs over time during exposure of the sampler to indoor air or soil gas. Unlike qualitative passive samplers, they have controlled and quantified uptake rates so they can be used to calculate concentrations and not simply mass adsorbed or relative concentrations. None were specifically designed for soil gas monitoring, and

the benefit of having data from both soil gas and indoor air is very attractive for vapor intrusion assessments. Two sets of laboratory experiments mimicked 1) indoor air sampling at different temperatures, relative humidity, wind speeds, and exposure times and at concentrations of 1, 50, and 100 ppb by volume, and 2) soil gas sampling at room temperature, ~100% relative humidity, 30-min exposure time, very low wind speed and concentrations of 1, 10, and 100 ppm by volume. Three rounds of field tests were conducted to demonstrate the practical applications.

<https://www.regonline.com/custImages/240809/Technical%20Presentations/2%20-%20HGroenevelt%20EMDO%20Presentation%2015-Apr-10.pdf>

#### Quantitative Site-Specific (2)H NMR Investigation of MTBE: Potential for Assessing Contaminant Sources and Fate

McKelvie, J.R., M. Elsner, A.J. Simpson, B. Sherwood Lollar, and M.J. Simpson.  
Environmental Science & Technology, Vol 44 No 3, p 1062-1068, 2010

Site-specific isotopic values of MTBE were measured using quantitative site-specific (2)H nuclear magnetic resonance (NMR) spectroscopy for seven commercially available MTBE products. The delta(2)H values of the methoxy and tertiary butyl groups ranged from -103 per thousand to -171 per thousand, and from -76 per thousand to -104 per thousand, reflecting their production from methanol and isobutene, respectively. Calculated delta(2)H values for MTBE, derived as weighted averages of (2)H NMR measurements of the two functional groups, showed good agreement with IRMS measurements. The ability to gain accurate information about the site-specific isotopic ratios of (2)H/(1)H within a molecule offers considerable promise as a new environmental tool to track the source and fate of environmental contaminants.

#### Quantum Cascade Laser-Based Photoacoustic Spectroscopy for Trace Vapor Detection and Molecular Discrimination

Holthoff, Ellen, John Bender, Paul Pellegrino, and Almon Fisher.  
Sensors, Vol 10 No 3, p 1986-2002, 2010

A microelectromechanical systems (MEMS)-scale photoacoustic sensor for the detection of trace gases uses a mid-infrared quantum cascade laser (QCL) to determine detection limits for acetic acid, acetone, 1,4-dioxane, and vinyl acetate. The source was continuously tunable from 1,015/cm to 1,240/cm, allowing for the collection of photoacoustic vibrational spectra for these gases. Exceptional agreement between the measured photoacoustic spectra and the infrared spectra for acetic acid, acetone, 1,4-dioxane, and vinyl acetate was observed. Partial least-squares regression was used to develop an algorithm for classification of these compounds based solely on photoacoustic spectra. <http://www.mdpi.com/1424-8220/10/3/1986/pdf>

#### Rapid Chemical and Biological Techniques for Water Monitoring

Gonzalez, C., R. Greenwood, and P.P. Quevauviller (eds).  
Wiley, New York. ISBN: 978-0-470-05811-4, 440 pp, 2009

This publication presents in one volume a broad spectrum of monitoring tools, both available and under development, and provides an assessment of their potential for underpinning environmental management. The book explores screening methods in the context of water policies, chemical methods, biological methods, potential use of screening methods, quality

assurance and validation methods, and integration of screening methods in water monitoring strategies.

#### Real-Time Contaminant Detection and Classification in a Drinking Water Pipe Using Conventional Water Quality Sensors: Techniques and Experimental Results

Yang, Y.J., R.C. Haught, and J.A. Goodric.

Journal of Environmental Management, Vol 90 No 8, p 2494-2506, 2009

The authors explored a real-time event adaptive detection, identification, and warning (READiw) methodology and examined it using pilot-scale pipe flow experiments of 11 chemical and biological contaminants each at three concentration levels. The tested contaminants include pesticide and herbicides (aldicarb, glyphosate and dicamba), alkaloids (nicotine and colchicine), E. coli in terrific broth, biological growth media (nutrient broth, terrific broth, tryptic soy broth), and inorganic chemical compounds (mercuric chloride and potassium ferricyanide). Through adaptive transformation of the sensor outputs, contaminant signals were enhanced and background noise was reduced in time-series plots leading to detection and identification of all simulated contamination events. The improved sensor detection threshold was 0.1% of the background for pH and oxidation-reduction potential (ORP), 0.9% for free chlorine, 1.6% for total chlorine, and 0.9% for chloride. The relative changes calculated from adaptively transformed residual chlorine measurements then were quantitatively related to contaminant-chlorine reactivity in drinking water. Based on these kinetic and chemical differences, the tested contaminants were distinguishable in forensic discrimination diagrams made of adaptively transformed sensor measurements.

#### Recent Achievements in Toxic Cyanide Monitoring: Review

Surleva, A.

Revue Electronique Internationale pour la Science et la Technologie [online], No 3, 2009

This review summarizes the determination of cyanide in environmental monitoring, with a discussion of the standard methods and their alternatives, including modern aspects of automatic portable systems design. The main requirements for detection systems in flow injection analysis, which is well-known to be the most suitable system for automation, are emphasized. Additionally, the potential of electrochemical measurements (amperometric and potentiometric) is discussed in detail.

<http://www.revue-genie-industriel.info/document.php?id=812>

#### Sampling, Defining, Characterising and Modeling the Rhizosphere: The Soil Science Tool Box

Luster, J., A. Goettlein, B. Nowack, and G. Sarret.

Plant and Soil, Vol 321 Nos 1-2, p 457-482, 2009

The authors review methods and models that help to assess how root activity changes soil properties and affects the fluxes of matter in the soil. Subsections discuss (1) experimental systems, such as plant treatments in artificial media, studying the interaction of model root and microbial exudates with soil constituents, and microcosms to distinguish between soil compartments differing in root influence; (2) the sampling and characterization of rhizosphere soil and solution, focusing on the separation of soil at different distances from roots and the

spatially resolved sampling of soil solution; (3) cutting-edge methodologies to study chemical effects in soil, including the estimation of bioavailable element or ion contents (biosensors, diffusive gradients in thin films), studying the ultrastructure of soil components, localizing elements and determining their chemical form (microscopy, diffractometry, spectroscopy), tracing the compartmentalization of substances in soils (isotope probing, autoradiography), and imaging gradients in situ with micro electrodes or gels or filter papers containing dye indicators; (4) spectroscopic and geophysical methods to study plant influence on the distribution of water in soils; and (5) the modeling of rhizosphere processes. Macroscopic models with a rudimentary depiction of rhizosphere processes are used to predict water or nutrient requirements, estimate biogeochemical element cycles, calculate soil water transport on a profile scale, or simulate the development of root systems. Microscopic or explanatory models are based on mechanistic or empirical relations that describe processes on a single root or root system scale and/or chemical reactions in soil solution.

<http://hal-sde.archives-ouvertes.fr/docs/00/34/34/96/PDF/Luster-PS-2008-HAL.pdf>

SAW RFID-Tags for Mass-Sensitive Detection of Humidity and Vapors  
Lieberzeit, Peter A., Christian Palfinger, Franz L. Dickert, and Gerhard Fischerauer.  
Sensors, Vol 9 No 12, p 9805-9815, 2009

One-port surface acoustic wave (SAW) devices with defined reflector patterns give characteristic signal patterns in the time domain, making them identifiable and leading to so-called RFID-Tags. Each sensor responds with a burst of signals, their timed positions giving the identification code, while the amplitudes can be related to the analyte concentration. This paper presents the first combination of such a transducer with chemically sensitive layer materials. These include crosslinked polyvinyl alcohol for determining relative humidity and tert-butylcalix[4]arene for detecting solvent vapors coated on the free space between the reflectors. In going from the time domain to the frequency domain by Fourier transformation, changes in frequency and phase lead to sensor responses, making it is possible to measure the concentration of PCE in air down to 50 ppm, as well as 1% changes in relative humidity. The RFID-Tag achieves the necessary recognition abilities as well as sensitivity and potentially could contribute to workplace monitoring at drycleaning establishments.

<http://www.mdpi.com/1424-8220/9/12/9805/pdf>

Sediment Matrix Effects in Analysis of Pyrethroid Insecticides Using Gas Chromatography-Mass Spectrometry

Wang, D., J. You, and M.J. Lydy.

Archives of Environmental Contamination and Toxicology 2010 Mar 26. [Epub ahead of print]

A gas chromatography-quadrupole mass spectrometry method has been developed for analyzing 9 pyrethroid insecticides in sediment after accelerated solvent extraction and solid-phase extraction cleanup. The operation was optimized, and negative chemical ionization was selected to improve analytical selectivity. The sediment matrix effects on qualification were evaluated, and matrix-matched standard solutions, along with the internal standard calibration, were used to reduce the matrix-induced chromatographic response enhancement. The method detection limits were 0.68 to 1.43 ug/kg dry weight (dw), and recoveries were 70.3 to 143.3%, 61.1 to 169.7%, and 65.7 to 118.8%, with relative SDs of 4.2 to 32.1%, 4.9 to 23.6%, and 1.5 to

23.3% at the spiked levels of 1.0, 5.0, and 20 ug/kg dw, respectively. The method was also validated by measuring pyrethroids in field-contaminated sediment samples collected in central California and southern Illinois.

Semiconducting Metal Oxide Based Sensors for Selective Gas Pollutant Detection  
Kanan, Sofian M., Oussama M. El-Kadri, Imad A. Abu-Yousef, and Marsha C. Kanan.  
Sensors, Vol 9 No 10, p 8158-8196, 2009

This paper presents a review of published literature focused on semiconducting metal oxide (SMO)-based sensors for the selective and sensitive detection of various environmental pollutants. <http://www.mdpi.com/1424-8220/9/10/8158/pdf>

Sensor Network Design for Drinking Water Contamination Warning Systems: A Compendium of Research Results and Case Studies Using the TEVA-SPOT Software  
Murray, R., T. Haxton, and R. Janke (National Homeland Security Research Center, Cincinnati, OH); W.E. Hart, J. Berry, and C. Phillips (Sandia National Laboratories, Albuquerque, NM).  
EPA 600-R-09-141, 92 pp, Apr 2010

The purpose of this report is to provide documentation on strategies and tools needed to assist in the design of an online sensor network for a contamination warning system (CWS). A key aspect of CWS design is the strategic placement of sensors throughout the distribution network. Chapter 1 provides background information and an overview of the research on sensor placement methods. Chapter 2 discusses the data required as input to sensor placement methods, highlighting the important design decisions a utility would need to make. Chapter 3 describes the iterative decision-making process to follow when implementing optimization software. Chapter 4 provides several real-world case studies, and Chapter 5 discusses several common challenges that a user might face when applying sensor placement software to real water systems. Chapter 6 is focused on the methodology for estimating the impacts of drinking water contamination, including methods for estimating dose and public health response. Chapter 7 describes the optimization problem for locating sensors. Appendix A includes a literature review.  
<http://www.epa.gov/nhsrc/pubs.html>

Sequential Extraction and DXRD Applicability to Poorly Crystalline Fe- and Al-Phase Characterization from an Acid Mine Water Passive Remediation System  
Carballo, M.A., T.S. Roetting, J.M. Nieto, and C. Ayora.  
American Mineralogist, Vol 94 No 7, p 1029-1038, 2009

Reliable characterization of iron and aluminum precipitates is problematic due to the high proportion of amorphous or poorly ordered mineral phases comprising these precipitates and because of their coexistence with intermediate to highly crystalline phases. To facilitate and improve the characterization of poorly ordered Fe and Al phases, a coupled differential X-ray diffraction (DXRD) and sequential extraction (SE) study was performed on a set of samples from an acid mine water passive treatment system. The techniques allowed a quantitative estimation of the proportion of each mineral present. As a result, a complete study of the distribution of each mineral throughout the reactive material profile and the role of each phase in removing metals from the mine water could be obtained. The results can be used to improve the reactive material design and to understand the natural processes taking place in aquatic systems affected by mining.

### Short-Term Exposure Testing of Six Different Passive Samplers for the Monitoring of Hydrophobic Contaminants in Water

Allan, I.J., K. Booij, A. Paschke, B. Vrana, G.A. Mills, and R. Greenwood.

Six passive sampling devices were tested: Chemcatcher, two modified versions of the membrane enclosed sorptive coating (MESCO I (m) and MESCO II), silicone rod and strip, and semipermeable membrane device (SPMD). Samplers spiked with a range of performance reference compounds (PRCs) were exposed for 5 days in a continuous flow-through tank using Meuse river water fortified with fluctuating concentrations (20 to 700 ng/L) of PAHs, PCBs, hexachlorobenzene, and p,p'-DDE. Sampler performance was evaluated by comparing masses accumulated in the devices only for analytes for which uptake was linear (integrative) and limited by transport across the boundary layer. Consistent data were obtained across the range of samplers despite the analysis being conducted in three separate laboratories and the different sampler configurations. The pattern in analyte masses accumulated by Chemcatcher and MESCO II data could be explained by the extraction and analysis being conducted only on the receiving phase of the samplers and a significant impact of the lag-phase prior to obtaining a steady flux of contaminants across the polyethylene membranes.

### Simultaneous Determination of Cadmium, Lead, Copper and Mercury Ions Using Organofunctionalized SBA-15 Nanostructured Silica Modified Graphite-Polyurethane Composite Electrode

Cesarino, I., E.T.G. Cavalheiro, and C.M.A. Brett.

Electroanalysis, Vol 22 No 1, p 61-68, 2010

A new sensor has been developed for the simultaneous detection of cadmium, lead, copper, and mercury by using differential pulse and square wave anodic stripping voltammetry (DPASV and SWASV) at a graphite-polyurethane composite electrode with SBA-15 silica organofunctionalized with 2-benzothiazolethiol as bulk modifier. The heavy metal ions were preconcentrated on the surface of the modified electrode at -1.1 V vs. SCE where they complex with 2-benzothiazolethiol and are reduced to the metals, and then are reoxidized. Optimum SWASV conditions lead to nanomolar detection limits and simultaneous determination of the subject metals in natural waters.

### Simultaneous Determination of Organophosphorus Insecticides in Various Food Matrices Using Solid Phase Microextraction

Tsoutsis, C.S., I.K. Konstantinou, D.G. Hela, and T.A. Albanis.

CEST2009: Proceedings of the 11th International Conference on Environmental Science and Technology, 3-5 September 2009, Chania, Crete, Greece. p A-1456-1462, Sep 2009

The applicability of headspace solid-phase microextraction (HS-SPME) for the analysis of 9 organophosphorus pesticides (OPs) (dimethoate, diazinon, fenitrothion, malathion, fenthion, parathion ethyl, methyl bromophos, methidathion, ethion) and 4 metabolites (omethoate, malaaxon, fenthion sulfoxide, and fenthion sulfone) in olives, olive oil, milk, and vegetables (tomato and cucumber) samples has been studied. To perform the HS-SPME, 6 commercial fibers were compared based on their absorption capacities, and PDMS fiber (100  $\mu$ m) was selected for further essays. The influence of various parameters on HS-SPME efficiency for OPs was studied using GC-FTD. Parameters such as fiber type, extraction time and temperature, agitation, salt addition, and dilution were investigated and optimized to increase specificity and

sensitivity of analysis. Also evaluated was the effect of the oil (acidity, fatty acids, triglycerides, sterols) and milk (fat content) matrices on the pesticide recoveries. Acidity and total amount of sterols were found to be the most influential factors for the SPME efficiency in oil samples, while the efficiencies of OPs in milk samples were dependent on the fat content. To address the matrix effects, quantitation of pesticides was achieved using internal standard or standard addition method in all matrices. HS-SPME is a robust and sensitive methodology for the determination of OPs in food matrices and overcomes limitations and obstacles of conventional methods, such as the use of organic solvents and the formation of emulsions. The results obtained allow application of the developed methods to investigations and monitoring studies of pesticide residues in food samples.

[http://www.srcosmos.gr/srcosmos/generic\\_pagelet.aspx?pagelet=Article%20summary&pub\\_id=12561](http://www.srcosmos.gr/srcosmos/generic_pagelet.aspx?pagelet=Article%20summary&pub_id=12561)

#### Solvent Vapour Detection with Cholesteric Liquid Crystals: Optical and Mass-Sensitive Evaluation of the Sensor Mechanism

Mujahid, A., H. Stathopoulos, P.A. Lieberzeit, and F.L. Dickert.  
Sensors, Vol 10 No 5, p 4887-4897, 2010

Cholesteric liquid crystals (CLCs) are used as sensitive coatings for the detection of organic solvent vapors for both polar and non-polar substances. The incorporation of different analyte vapors in the CLC layers disturbs the pitch length which changes the optical properties, i.e., shifting the absorption band. The engulfing of CLCs around non-polar solvent vapors such as tetrahydrofuran (THF), chloroform, and PCE is favored in comparison to polar ones, i.e., methanol and ethanol. Increasing solvent vapor concentrations shift the absorbance maximum to smaller wavelengths, e.g., as observed for THF. Additionally, CLCs have been coated on acoustic devices such as the quartz crystal microbalance to measure the frequency shift of analyte samples at similar concentration levels. The mass effect for PCE was about six times higher than for chloroform. Thus, optical response can be correlated with intercalation in accordance to mass detection. Mechanical stability was gained by combining CLCs with imprinted polymers, and pre-concentration of solvent vapors led to additional selectivity.

<http://www.mdpi.com/1424-8220/10/5/4887/pdf>

#### Spectroscopic Interpretation of PAH-Spectra in Minerals and Its Possible Application to Soil Monitoring

Ko, E.-J., K.-W. Kim, K. Park, J.-Y. Kim, J. Kim, S.-Y. Hamm, J.-H. Lee, and U. Wachsmuth.  
Sensors, Vol 10 No 4, p 3868-3881, 2010

The variation of fluorescence intensity due to the heterogeneity and complexity of soil media was investigated to assess the feasibility of using laser-induced fluorescence (LIF) spectroscopy for soil monitoring. Different soil minerals showed fluorescence spectral structures distinguishable from the contaminants, suggesting dissimilar interactions or the binding of contaminants on mineral surfaces. Solvent and water addition gave different responses in the fluorescence spectral structure, showing their effect on the interactions between contaminants and minerals. These results support the claim that the spectral structure contains information on contaminant-mineral interactions; therefore contaminants can be used as a fluorescence probe for these interactions. <http://www.mdpi.com/1424-8220/10/4/3868/pdf>

## Study of Matrix Effects and Spectral Interferences in the Determination of Lead in Sediments, Sludges and Soils by SR-ETAAS Using Slurry Sampling

Savio, M., S. Cerutti, L.D. Martinez, P. Smichowski, and R.A. Gil.

Talanta, Vol 82 No 2, p 523-527, 15 July 2010

An interference-free, fast, and simple method is proposed for Pb determination in environmental solid samples by combining slurry sampling and electrothermal atomic absorption spectrometry. Samples were ground to an adequate particle size and slurries were prepared by weighing from 0.05 g to 0.20 g of dry sediment, adding nitric acid, and a solution containing 0.1% Triton X-100. Ultrasonic agitation was employed for slurries homogenization. Analytical variables including acid pre-treatment conditions, particle size, slurry stability, temperature program of the graphite furnace, and type and concentration of the chemical modifier were studied. For calibration, synthetic acid solutions of Pb were employed. Calibration was linear within the range 1 to 30 ug/L and 5 to 30 ug/L when the 217.0 nm and 283.3 nm analytical lines were used. Correlation coefficients of 0.9992 and 0.9997 were obtained. Using optimized conditions, limits of detection (3sigma) of 0.025 ug/g and 0.1 ug/g were achieved for the 217.0 nm and 283.3 nm analytical lines, respectively. The method was applied successfully to the determination of lead in soil, contaminated soil, municipal sludge, and sediment samples. Accuracy was assessed by the analysis of two certified reference materials, municipal sludge (QC MUNICIPAL SLUDGE A) and lake sediment (TRAP-LRM from IJS).

## T2 Mass Flux Portal

Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools Web site, Feb 2009

Mass flux is emerging as an alternative approach for assessing sites with source-zone contaminants and for evaluating the performance of remedial treatments. Mass flux is a calculation of the mass of dissolved contaminants that passes through a cross-sectional area over time. Mass flux is expressed in the units of mass per time per area (e.g., lbs/hr/ft<sup>2</sup>). It provides an estimate of dense nonaqueous-phase liquid (DNAPL) source strength and the rate of mass loading to the dissolved phase. Mass flux offers a potential improvement over estimates of the percentage of mass removal because of the high uncertainty in direct measurements of DNAPL mass in the subsurface. This Web Portal provides a brief overview of the methods and tools used to measure mass flux and provides links to useful resources in mass flux research. The use of mass flux currently is not a widespread practice; however, researchers have proposed the use of mass flux estimates as one more tool to characterize site conditions and to assess remedial action performance before and after remediation of a DNAPL source zone. Various methods that have been proposed for measuring mass flux, all of which have been tested successfully in field applications. The Portal provides detailed information in separate sections for four methodologies: (1) High Resolution Piezocone; (2) Integral Pumping Test; (3) Passive Flux Meter; and (4) Mass Flux Transect. <http://www.ert2.org/t2massfluxportal/>

## TARGOST(r): High Resolution NAPL Characterization of MGP, Wood Treater, and Coking Waste NAPL

St. Germain, R., Dakota Technologies, Inc.

The Michigan Environmental Professional, p 10-14, 2009

Efficient remediation of former manufactured gas plants (MGPs), wood treater, and coking sites is contingent on accurate delineation of source-term DNAPLs, such as coal tar and

creosote. They are "heavy" in terms of their relatively high proportion of large polycyclic aromatic hydrocarbons (PAHs) or similar cyclic compounds. Heavy NAPL tar/oil delineation and characterization traditionally involves sampling of subsurface soils using test pits, drill rigs or direct push sampling, logging of the boreholes by a geologist, and on- or off-site analysis of soil samples. The delineation process can be time-consuming, expensive, and dirty due to heavy NAPLs' odor and the difficulty associated with cleaning sampling equipment. The nature of these compounds can make it difficult to develop an accurate conceptual site model as heavy NAPLs often exist in both LNAPL and DNAPL phases. Because heavy NAPLs contain large PAH molecules, they are fluorescent, or spectroscopically active. The Tar-specific Green Optical Screening Tool (TarGOST(r)) exploits this fluorescent property, deriving the location and relative concentrations of heavy NAPLs in the subsurface by measuring their fluorescence. TarGOST(r) is essentially a front-face laser-induced fluorescence fluorometer that sends ultra-fast pulses (three billionths of a second in duration) of laser excitation light down a fiber-optic cable. The fiber optic delivers laser light through the direct push rod string and into a drive head containing a sapphire window, which allows the light to interact with the soil. The laser light strikes the soil matrix as the probe is steadily pushed or jack-hammered into the subsurface. Fluorescence emitted by heavy NAPL (and even some laser light that is scattered off the soil) is collected by a second fiber optic and returned uphole to the instrument for detection, analysis, and storage of data versus depth. The latest generation TarGOST(r) system employs a high-rate laser and detector that measure the fluorescence and scatter ~100 times each second as the probe is advanced to depths typically ranging from 25 to 50 feet. Maximum achievable depth is dependent on the geology. In addition to the device's capacity for formal chemical analysis, TarGOST(r) logs are useful for determining the distribution of the NAPL at a particular location, particularly when the logs are merged with GIS information and viewed collectively to convey the site's NAPL distribution relative to other features.

[http://www.maep.org/docs/MAEP\\_Spring\\_09\\_Newsletter.pdf](http://www.maep.org/docs/MAEP_Spring_09_Newsletter.pdf)

#### Technical Basis for Evaluating Surface Barriers to Protect Groundwater from Deep Vadose Zone Contamination

Fayer, M.J., A.L. Ward, and V.L. Freedman.  
PNNL-18661, 57 pp, Feb 2010

Studies by researchers at the Hanford site and Pacific Northwest National Laboratory suggest that surface barriers have the potential to provide a significant degree of isolation of contaminants located deep in the vadose zone. The studies show that the actual degree of isolation is site-specific and depends on many factors, including recharge rates, barrier size, depth of contaminants, geohydrologic properties of the sediments, and the geochemical interactions between the contaminants and the sediments. This document presents a strategy for evaluating the effectiveness of surface barriers for site-specific mitigation of deep vadose zone contamination. The strategy provides a technically defensible approach to determine the depth to which a surface barrier can isolate contaminants effectively in the vadose at a specific site as a function of subsurface properties, contaminant distribution, barrier design, and infiltration control performance. The strategy provides an assessment of additional data and information needs with respect to surface barrier performance for deep vadose zone applications and also addresses the linkage between surface barriers and in situ remediation activities, monitoring issues, and emerging science, technology, and regulatory objectives. This report documents the

existing knowledge base, identifies knowledge needs (based on data gaps), and suggests tasks whose outcomes will address those knowledge needs. The report also serves as a starting point to engage the regulator and stakeholder community on the viability of deploying surface barriers for deep vadose zone contamination. <http://www.osti.gov/bridge/purl.cover.jsp?purl=/973406-lks09E/>

Tiny Sensors Tucked into Cell Phones Could Map Airborne Toxins in Real Time  
University of California - San Diego News Release, 12 May 2010

A tiny silicon chip that works a bit like a nose may one day detect dangerous airborne chemicals and alert emergency responders through the cell phone network. If embedded in many cell phones, the new type of sensor could triangulate and map the location and extent of hazards like gas leaks or the deliberate release of a toxin, mapping a chemical accident as it unfolds. In collaboration with Rhevision, Inc., a small startup company located in San Diego, the UCSD research group has completed the first phase of development of the sensor and has begun to work on a prototype that will link to a cell phone. The sensor, a porous flake of silicon, changes color when it interacts with specific chemicals. By manipulating the shape of the pores, the researchers can tune individual spots on the silicon flake to respond to specific chemical traits. The pattern of color changes across the surface of the chip reveals the identity of the chemical. The chips can distinguish between methyl salicylate, a compound used to simulate the chemical warfare agent mustard gas, and toluene, a common additive in gasoline. To focus on the fine-scale detail in the optical array, the team uses a new kind of supermacro lens that works more like an animal's eye than a camera lens. The lens, developed by Rhevision, uses fluid rather than bulky moving parts to change its shape and focus. Sensitivity to additional chemicals is on the way. Carbon monoxide sensors on the masks of firefighters could warn them when to switch to self-contained breathing devices. Similar sensors might warn miners of the buildup of explosive gases. The research effort is led by Michael Sailor, professor of chemistry and biochemistry at UCSD. Adrian Garcia Segal, a graduate student in Sailor's laboratory, is leading the effort to develop the sensors. Gordon Miskelly, deputy director of forensic science at the University of Auckland in New Zealand developed the imaging array sensing methodology. Yu-Hwa Lo, professor of electrical and computer engineering at UC San Diego's Jacobs School of Engineering and founder of Rhevision developed the lens. Truong Nguyen, professor of electrical and computer engineering at the Jacobs School, is developing the computing algorithms to discriminate between different patterns. The project is funded by the Department of Homeland Security. [http://www.eurekalert.org/pub\\_releases/2010-05/uoc--tst051210.php](http://www.eurekalert.org/pub_releases/2010-05/uoc--tst051210.php)

UCLA Engineers Develop Faster Method to Detect Bacterial Contamination in Coastal Waters  
Chin, Matthew.

University of California at Los Angeles News Release, 2 Mar 2009

Rapid determination of coastal water-quality conditions is generally a 24-hour process, but engineers from the UCLA Henry Samueli School of Engineering and Applied Science have sped up the process of analyzing bacterial concentrations to under one hour through the development of a new, in-field, rapid-detection method. Jenny Jay, UCLA associate professor of civil and environmental engineering, and Ph.D. student Christine Lee have advanced and tested a rapid method in marine and freshwater samples from beaches in Malibu and Santa Monica. To

their knowledge, it is among the first viable in-field methods for rapid, portable analysis of fecal bacteria. This research will be published in an upcoming issue of the Journal of Applied Microbiology. The paper's co-authors are UCLA electrical engineering professor William Kaiser and John Griffith, Ph.D., a senior microbiologist with the Southern California Coastal Water Research Project. The new rapid process uses magnetic beads conjugated to specific antibodies that identify and bind fecal bacteria used as standards for determining the safety of recreational waters, such as *E. coli* and *Enterococcus*. After a few filtration and isolation steps, the sample organisms are lysed and treated with an enzyme that catalyzes a light-emitting reaction with target ATP, the energy currency of a cell. Cells break down ATP to obtain energy important for cellular processes. Through use of a luminometer, a device that detects light emissions, bacterial concentrations can be determined based on how much light is released. The process is called covalently linked immunomagnetic separation/adenosine triphosphate quantification technique (Cov-IMS/ATP).

<http://www.newsroom.ucla.edu/portal/ucla/ucla-engineers-developed-faster-154426.aspx>

#### Ultramicroelectrode Array Based Sensors: A Promising Analytical Tool for Environmental Monitoring

Orozco, J., C. Fernandez-Sanchez, and C. Jimenez-Jorquera.  
Sensors, Vol 10 No 1, p 475-490, 2010

The analytical performance of ultramicroelectrode arrays (UMEAs) has led to the development of a variety of electroanalytical applications. UMEA-based approaches can provide powerful, simple, rapid, and cost-effective analytical tools for environmental analysis compared to available conventional electrodes and standardized analytical techniques. This paper presents an overview of the fabrication processes of UMEAs, their characterization, and applications carried out in Spain; gives a brief explanation of theoretical aspects that highlight their electrochemical behavior; and discusses the application of this transducer platform in the environmental field. <http://www.mdpi.com/1424-8220/10/1/475/pdf>

#### Use of Microbiological and Chemical Methods for Assessment of Enhanced Hydrocarbon Bioremediation

Alamri, S.A.

Journal of Biological Sciences, Vol 9 No 1, p 37-43, 2009

A suite of microbiological tools complementing the standard chemical analysis was used for evaluating the effect of steam and surfactant on the rate of hydrocarbon biodegradation. The microbiological monitoring tools were soil microbial counts, soil microbial respiration, and microbial toxicity biosensor. An investigation of the correlations between these parameters and with the levels of hydrocarbon residues showed that bioremediation was an effective method for reducing hydrocarbon concentration; however, the monitoring tools used revealed that steam and surfactant had no significant effect upon the rate of hydrocarbon bioremediation or toxicity reduction compared with the control. The study also showed that a combination of different classes of biological and chemical tools would be more effective in monitoring hydrocarbon bioremediation than any single approach.

<http://docsdrive.com/pdfs/ansinet/jbs/2009/37-43.pdf>

Using Electrical Resistivity Imaging to Evaluate Permanganate Performance During an In Situ Treatment of a RDX-Contaminated Aquifer

Comfort, S. and V. Zlotnik (Univ. of Nebraska, Lincoln); T. Halihan (Oklahoma State Univ.). Environmental Security Technology Certification Program (ESTCP), Project ER-0635, 132 pp, Aug 2009

Electrical resistivity imaging (ERI) is a geophysical technique that infers subsurface water and soil electrical properties. Where the soil, contaminant(s), and remediation compound are suitable, ERI quickly and economically provides the investigator with a spatially extensive, high-density, high-quality model of subsurface conditions. ERI has earned success in research and applications by reliably locating contaminant targets where traditional drilling and direct push methods have failed to locate contamination. In this demonstration project, ERI was used to monitor an injection of sodium permanganate to mineralize RDX at the former Nebraska Ordnance Plant. [RDX and TCE were commingled in the plume, but TCE is not discussed in this report.] Monitoring wells showed that the in situ chemical oxidation (ISCO) treatment was transforming the RDX, but samples from 17 available wells and 8 direct-push profiles at different locations did not provide enough data to construct the distribution and flow of the injected permanganate. ERI showed that the permanganate injection flowed against the regional groundwater gradient, and that the solution was able to sink below the monitoring well screens. Without geophysical observations, no information would have been available to explain the permanganate and RDX concentrations observed in the wells. The same data were used to guide the boring of additional holes; unguided drilling would be a costly and inefficient option, based on essentially random location choices. ERI demonstrated its usefulness and value in monitoring a permanganate injection. The technology should be explored further and developed for use in pre-amendment tracer tests and quantitative remedial assessments. Final Report:

<http://www.estcp.org/Technology/upload/ER-0635-FR.pdf>

See also the ESTCP Cost and Performance Report:

<http://www.estcp.org/Technology/upload/ER-0635-C&P.pdf>

Using Remote Sensing to Assess Impact of Mining Activities on Land and Water Resources  
Charou, E., M. Stefouli, D. Dimitrakopoulos, E. Vasiliou, and O.D. Mavrantza.

Mine Water and the Environment, Vol 29 No 1, p 45-52, 2010

Remote sensing data enable the identification, delineating, and monitoring of pollution sources and affected areas, including derelict land and changes in surface land use and to water bodies. The use of multi-temporal Landsat-5 and Landsat-7 images, SPOT Panchromatic, and ASTER data was evaluated for mapping the natural environment on a local scale and assessing the impact of mining activities by indicating the changes on land and water resources. Three case studies are presented: Lake Vegoritis and the Amynteon mine (both located in northern Greece) and the Lavrio mine area, in central Greece. The use of high-resolution satellite remote sensing data and state-of-the-art GIS techniques with parallel development of a fully integrated geospatial database system provided monitoring and feedback at appropriate spatial scales; which indicates that such data can be used for long-term environmental management and monitoring of reclamation and rehabilitation of mining areas.

<http://www.springerlink.de/content/y667586772663757/fulltext.pdf>

The Utility of Using Background Fluorescence Analysis and Fluorescent Dye-Tracing to Effectively Constrain Organic Contaminant Migration and Assess Remediation Strategies  
Otz, I., M.H. Otz, and D.I. Siegel.

IPEC 2009: 16th Annual International Petroleum & Biofuels Environmental Conference, 2-5 November, Albuquerque, New Mexico. Poster, 2009

The unknown heterogeneity in permeability distributions commonly creates uncertainties in designing effective remediation strategies. The refraction of groundwater flow paths at permeability interfaces force flow paths and contaminant plumes to not follow the maximum hydraulic gradient from contaminant sources. This poster report the results of multiple evaluations of the intrinsic fluorescence of aromatic and aliphatic organic compounds showing that the dissolved and the pure phase of organic contaminants of concern commonly divert tens of degrees from the maximum direction of the hydraulic gradients. Unlike analyses of specific compounds, the natural fluorescence fingerprints of organic contamination reflect the entire organic load of water; much like specific conductance reflects the inorganic load. The organic load includes not only compounds of regulatory interest but also their degradation products. The actual directions of contaminant migration along preferential groundwater flow paths can be determined with selective dyes (even in organic-rich environments) often within 2-4 months, and therefore well within the timeframe of most remedial investigation studies. In these projects, full recovery of dye becomes less important than where in which monitoring well the dye can be identified. [http://ipec.utulsa.edu/Conf2009/Abstracts%202009/OtzI\\_Poster\\_28.pdf](http://ipec.utulsa.edu/Conf2009/Abstracts%202009/OtzI_Poster_28.pdf)

Validation of a Method for the Analysis of PAHs in Bulk Lake Sediments Using GC-MS  
Yamada, T.M., D.A. Souza, C.R. Morais, and A.A. Mozeto.

Journal of Chromatographic Science, Vol 47 No 9, p 794-799, Oct 2009

This work presents the validation procedures for an analytical method to determine the 16 PAHs from U.S. EPA's priority pollutants list in sediment samples using ultrasonic extraction coupled to GC-MS. The extraction techniques are altered by the construction of an extraction flask adapted to the ultrasonic bath that greatly reduces losses and increases extraction efficiency of the volatile compounds, especially naphthalene. Cleanup procedures are also altered to change the polarity of the solvent mixture that contributes to reducing the elution of undesirable compounds. The PAH-spiked sediment at 100 ug/kg level shows a recovery rate of 68 to 108%. A certified reference material has been analyzed for those compounds showing results conforming to certified values. The optimized procedure is applied to sediment field samples from different areas across Southeast Brazil. The total PAH concentration in these sediment samples varies between 103.96 and 180.87 ug/kg (dry weight). As the detected concentrations are relatively low, the acute toxicity detected in sediment and its pore water is not due to the PAH compounds, but to high concentrations of ammonia, copper, and nickel.

Whole-Cell Fluorescent Biosensors for Bioavailability and Biodegradation of Polychlorinated Biphenyls

Liu, X., K.J. Germaine, D. Ryan, and D.N. Dowling.

Sensors, Vol 10 No 2, p 1377-1398, 2010

Whole-cell microbial biosensors are one of the newest molecular tools used in environmental monitoring. Such biosensors are constructed through fusing a reporter gene such as lux, gfp, or lacZ to a responsive promoter. There have been many reports of the applications

of biosensors, particularly their use in assaying pollutant toxicity and bioavailability. This paper reviews the basic concepts behind the construction of whole-cell microbial biosensors for pollutant monitoring, and describes the applications of two such biosensors for detecting the bioavailability and biodegradation of PCBs. <http://www.mdpi.com/1424-8220/10/2/1377/pdf>

## SBIR and Other Grant Awards

### National Science Foundation

A Hybrid Electronic Tongue for Geoenvironmental Site Characterization (NSF 2010 Standard Grant)

University of Massachusetts Lowell

Pradeep Kurup, PI, [Pradeep\\_Kurup@uml.edu](mailto:Pradeep_Kurup@uml.edu), 978-934-4723; Ramaswamy Nagarajan, Co-PI  
NSF Award 1031505

Sep 1, 2010 - Aug 31, 2013

\$374,859

This project will support the development of a novel 'electronic tongue cone penetrometer' for on-site characterization of heavy metals such as arsenic, cadmium, copper, chromium, lead, manganese, mercury, nickel, selenium, thallium, and zinc in soil and groundwater. The electronic tongue is a device that mimics the human gustatory system using microelectrode sensor arrays coupled with artificial intelligence for pattern recognition. The project will involve fundamental research to design and assemble materials for highly sensitive and broadly selective microelectrode sensors, followed by the development of conductometric and voltammetric techniques for the hybrid electronic tongue. In addition, intelligent machine learning models for multivariate data processing and interpretation will be developed for classification and quantification of heavy metals. Calibration chamber studies will be conducted to develop methods for analysis of heavy metals in aqueous soil samples. Finally, the microelectrode sensor arrays will be deployed in a field-rugged cone penetrometer to facilitate real-time geoenvironmental site characterization.

An Improved Open-Path FTIR Spectrometer for Remote Monitoring of Atmospheric Gases (NSF 2010 SBIR Phase 1)

Energetiq Technology, Inc., Woburn, MA

Stephen Horne, PI, [shorne@energetiq.com](mailto:shorne@energetiq.com), 781-939-0763

NSF Award 1013317

July 1, 2010 - Dec 31, 2010

\$149,252

This SBIR Phase I project will develop an improved open-path FTIR spectrometer for monitoring atmospheric gases over extended distances. This will be achieved by developing a high-brightness infrared source that is heated to 2000 K by means of a diode laser. This will enable the instrument to be less bulky and expensive, and will have improved monitoring range over current systems.

In Situ Cyanide Monitoring in Gold Mine Effluents (NSF 2010 STTR Phase 1)

United Science LLC, Center City, MN

Jon Thompson, PI, 651/213-6185, [jthompson@unitedsciencecorp.com](mailto:jthompson@unitedsciencecorp.com); Philippe Buhlmann, Co-PI

NSF Award 1010153

July 1, 2010 - June 30, 2011

\$150,000

Phase I will address the unmet analytical needs for monitoring cyanide leaching of gold, a process widely used in the mining industry to refine gold ores. The goal is to establish the feasibility of sensors that permit the selective measurement of free and complexed cyanide in the cyanide leach reactor, detoxification reactor, and in the tailings facilities. The sensors are ideally suited for these measurements since they are expected to be unaffected by turbidity, to have a cyanide selectivity that can be tuned with specific receptors, and to require no off-stream sample handling. The project will take advantage of highly selective and fouling-resistant fluorinated perfluoropolymer membranes. More effective control of cyanide usage is expected to minimize accidental cyanide discharges significantly and thereby, reduce resulting negative impact on the environment.

In Situ Stand-alone Monitor for Rapid Toxicity Detection (NSF 2010 SBIR Phase 1)

Intelligent Optical Systems, Inc., Torrance, CA

Jesus Delgado, PI, 310-530-7130, [sbirproposals@intopsys.com](mailto:sbirproposals@intopsys.com)

NSF Award 1014365

July 1, 2010 - Dec 31, 2010

\$119,519

This SBIR Phase I project will focus on the creation of a usable optical sensor for toxicity detection in waste water. The broader/commercial impact of the project will be to transform the wastewater industry through increased automation and accuracy.

Integrated Sensing and Acting with Tunable Chemical Sensors (NSF 2010 Standard Grant)

Texas Engineering Experiment Station, College Station, TX

Ricardo Gutierrez-Osuna, PI, [rgutier@cs.tamu.edu](mailto:rgutier@cs.tamu.edu), 979-458-7617

NSF Award 1002028

Sep 1, 2010 - Aug 31, 2013

\$299,930

The objective of this research is to develop probabilistic methods for active sensing with tunable chemosensors. The approach is formulated as a partially observable Markov decision process, whereby the system takes sequential sensing actions to identify a chemical target. The investigators will develop algorithms to adapt sensor tunings on the fly for two types of scenario: target discrimination and background rejection. These algorithms will be validated on two tunable sensor technologies (metal-oxide chemoresistors and infrared interferometers) combined with tunable preconcentrators. This research will lead to agile systems that can adapt sensing parameters on-the-fly in response to their environments. The work will also provide a better understanding of active sensing across a range of scenarios (e.g. static vs. dynamic stimuli) and sensor characteristics (e.g. specific vs. cross-selective).

Novel Nanostructured Substrates for Surface Enhanced Raman Spectroscopy (SERS) (NSF 2010 STTR Phase 1)

LXD, LLC, Cleveland, OH

Hailiang Zhang, PI, 440-786-8700, [kzhang@lxdinc.com](mailto:kzhang@lxdinc.com); Qihuo Wei, Co-PI

NSF Award 1010368

July 1, 2010 - June 30, 2011

\$149,755

This project will develop a new type of nanostructured substrate for applications in arsenide detection using surface enhanced Raman spectroscopy (SERS). SERS, which relies on Raman signal enhancements for molecules in close contact with noble metal nanostructures, can provide essential information for detection and identification of biological and chemical materials, including arsenic, but its application has been obstructed primarily by the lack of SERS substrates that can be fabricated with high performance and in a repeatable fashion. The proposed research aims to resolve this issue by developing SERS substrates through designing, fabricating, and testing a new nanostructured noble metal substrate. The broader impact/commercial potential of this project will be high-performance and low-cost SERS substrates that can be employed for monitoring drinking water for toxic substances, such as arsenic and cyanide.

### **Strategic Environmental Research and Demonstration Program (SERDP)**

Assessing Mercury and Methylmercury Bioavailability in Sediment Porewater Using Mercury-Specific Hydrogels (SERDP 2010 Grant)

Project ER-1771

Dr. Karen Merritt, ENVIRON International Corporation, Portland, ME, 207-347-4413, Ext. 227, [kmerritt@environcorp.com](mailto:kmerritt@environcorp.com)

Begin 2010 - End 2013

This project will assess the effectiveness of Hg- and MeHg-specific hydrogels as a field-based bioavailability screening tool. It will develop the relationship between hydrogel data and invertebrate tissue concentrations, and test hydrogels as a screening tool for the efficacy of reactive amendment addition to Hg-impacted sediment.

<http://www.serdp.org/Research/ER-1771-FS.cfm>

Development of an Electrochemical Surrogate for Copper, Lead, and Zinc Bioaccessibility in Aquatic Sediments (SERDP 2010 Grant)

Project ER-1748

Dr. Aaron Slowey, USGS, Menlo Park, CA, 650-329-5474, [aslowey@usgs.gov](mailto:aslowey@usgs.gov)

Begin 2010 - End 2011

This project will develop and test a scanned stripping chronopotentiometry (SSCP) tool for measuring the potential bioaccessibility of Cu, Pb, and Zn in aquatic sediments. SSCP is inexpensive, can quantify metals down to 0.4 nM, requires minimal sample handling, prevents matrix interference, can be interpreted with a minimum number of assumptions, and is complementary to bioassays. <http://www.serdp.org/Research/ER-1748-FS.cfm>

## **U.S. Department of Defense**

Rapid Air/Vapor Sampling System for Chemical Threats (DoD CBD 2009 SBIR Phase 1)  
Lynntech, Inc., College Station, TX  
Bikas Vaidya, PI, 979-693-0017  
CBD 09-106

Lynntech is proposing to develop an air/vapor sampling system capable of i) handling a high flow rate, ii) efficient capture, and iii) rapid release of the potential chemical threats (for analysis by GC). The feasibility of using Lynntech's air/vapor sampling system at 1L/min air flow at 90+/-2 degrees F and 80+/-5% RH will be demonstrated during Phase I, and a working prototype will be developed during the Phase II of the project.

## **U.S. Department of Energy**

Contaminant Specific Biosensor for Monitoring Heavy Metal and Radionuclide Bioremediation (DOE 2010 SBIR Phase 1)  
Lynntech, Inc., College Station, TX

This project will develop a novel biosensor to provide a real-time measurement of bioremediation rates of heavy metal and radionuclide contamination. The novel biosensor could lead to reduced costs and increased acceptance of bioremediation strategies.

Development of Microarrays-based Metagenomics Technology for Monitoring Sulfate-Reducing Bacteria in Subsurface Environments (DOE 2010 STTR Phase 1)  
Glomics, Inc., Norman, OK

This project will greatly assist the commercialization of GeoChip technologies. GeoChip is a metagenomic technology for simultaneously monitoring thousands of microorganisms important to energy, environmental management, agriculture, industry, foods, and human health.

Development of Novel Random Network Theory-Based Approaches to Identify Network Interactions Among Nitrifying Bacteria (DOE 2010 STTR Phase 1)  
Glomics, Inc., Norman, OK

This project will develop novel ecological network approaches to characterize network interactions of microbial communities to provide transformative advances in biological/environmental sciences, and this will greatly enhance the commercialization of GeoChip technologies, which was awarded as one of the 100 most technological innovations with the greatest commercial potentials in 2009.

Field-Deployable Water Isotope Analyzer for Stream Sampling (DOE 2009 SBIR Phase 2)  
Los Gatos Research, Mountain View, CA  
Dr. Manish Gupta, PI, [m.gupta@lgrinc](mailto:m.gupta@lgrinc)  
DOE Grant No. FG02-08ER84976  
\$320,672

This project will develop a field-deployable analyzer to continuously monitor water sources and help provide information about the storage, flow pathways, and source of water. Such measurements are critical to DOE waste remediation efforts.

A Field-Portable Polarization Imaging System for Remote Sensing (DOE 2009 SBIR Phase 2)  
Boston Applied Technologies, Inc., Woburn, MA

Dr. Hongzhi Zhao, PI, [hzhao@bostonati.com](mailto:hzhao@bostonati.com)

DOE Grant No. DE-FG 02-08ER85109

\$na

This project will develop an innovative, field-portable polarization imaging solution, based on a high performance electro-optic polarization management technology. The resulting instrument will contain no moving parts and will be amenable to integration with most existing CCD (Charge Coupled Device) cameras. In this approach, a gray-level co-occurrence matrix (GLCM) will be developed to represent the texture, and a support vector machine (SVM) will be used as the classifier to categorize targets. The technology should find application in many fields including environmental monitoring, medical diagnosis, biological fingerprint detection in life science, remote optical sensing and imaging, and target discrimination and minefield detection in defense.

H-PDLC Tunable Filter for Hyperspectral Imaging (DOE 2009 STTR Phase 2)

Opra, Inc., Topsfield, MA, partnered with Dr. Adam Fontecchio, Drexel University

DOE Grant No. FG02-08ER86355

\$750,000

This project will develop a fast spectrally tunable filter for remote surveillance applications such as airborne detection of activities associated with the production of weapons of mass destruction. A key attribute for this project is the ability to rapidly tune between the visible spectral bands to support hyperspectral imaging from a moving platform such as an aircraft.

High-Throughput Ultra-Fast Tunable Filter for Multispectral Imaging (DOE 2009 SBIR Phase 2)

Boston Applied Technologies, Inc., Woburn, MA

Quincy Chen, PI, [qchen@bostonati.com](mailto:qchen@bostonati.com)

DOE Grant No. DE-FG 02-08ER85110

\$na

Existing remote sensing technologies have limitations with respect to color-switching speed, temperature range, throughput, and spectral range. To address these limitations, a higher-performance tunable imaging filter is needed. This project will develop a unique filter based on an extremely large electro-optic effect. The approach will provide ultra-fast wavelength tuning--an ability to change wavelengths in microseconds--enabling higher spectral and spatial resolutions for remote sensing applications. The filter will cover the spectral range from visible to middle IR, with wide tunability. In addition, the filter will have very compact structure, high throughput, no moving parts, and all solid-state operation.

An In-Situ Instrument to Assess the Concentration and Phase Partitioning of Atmospheric Semi-Volatile Organic Compounds (DOE 2009 STTR Phase 2)

Aerosol Dynamics, Inc., Berkeley, CA, partnered with University of California, Berkeley

Dr. Susanne V. Hering, PI, [Susanne@aerosol.us](mailto:Susanne@aerosol.us)

DOE Grant No. DE-FG02-08ER86335

\$394,678

Previous work involved the development of the Thermal Desorption Aerosol Gas Chromatography Mass Spectrometer (TAG), which provides identification and quantification of organic constituents in atmospheric particles at the molecular level with hourly measurements. In this project, the collection and desorption system of the TAG will be modified to provide quantitative data on the concentration and phase partitioning of SVOC species at the molecular level.

In Situ Monitoring of Toxic Metals and Chlorinated Solvent Plumes using a Portable, Dual Sensor LIBS/Raman Device (DOE 2010 SBIR Phase 1)

Applied Spectra, Inc., Fremont, CA

This project will develop an instrument that is an environmentally-friendly laser device used to quickly detect the presence of radionuclides and other contaminants in the environment which will allow public officials the ability to make informed decisions about public health issues.

In-Situ Monitoring of Uranium in Ground Water Using a Colorimetric-Based Sensor: Enabling the Mapping of Uranium Plume Migration of Contaminated DOE Sites (DOE 2009 STTR Phase 2)

Burge Environmental, Inc., Tempe, AZ, partnered with Pacific Northwest National Lab (PNNL)

Dr. Scott R. Burge, PI, [burgenv@globalcrossing.net](mailto:burgenv@globalcrossing.net)

DOE Grant No. DE-FG02-08ER86341

\$374,471

In this project, an automated field-deployable monitoring system containing a preconcentrating column sensor will be used to monitor uranium concentrations. The system will be capable of being deployed and operated in the field for several months, measuring uranium concentrations below the regulatory limit of 30 ppb. The system will provide more frequent data with less reporting delay at a lower cost than the baseline methods.

Integrated Use of Surface and Subsurface NMR for Measuring and Mapping Saturated Hydraulic Conductivity in Three Dimensions (DOE 2010 STTR Phase 1)

Vista Clara Inc., Everett, WA

This project will develop and demonstrate a cost-effective, minimally invasive field method for using NMR geophysics to measure and map hydraulic conductivity in the top 100 m of the subsurface. The proposed methodology will provide reliable, higher-resolution information on this key subsurface property for improved understanding and remediation of contaminated groundwater.

Isotope Hygrometer for In Situ Subsurface Characterization (DOE 2010 SBIR Phase 1)  
Vista Photonics, Inc., Santa Fe, NM

This project will develop an isotope analyzer that can determine the isotope composition of liquid water samples. It will allow tracing the transport and dispersion of contaminants in the subsurface.

Lab-on-a-Chip Technology for In-Situ Mercury Speciation Characterization (DOE 2010 SBIR Phase 1)

Los Gatos Research, Mountain View, CA

New technologies are urgently needed for long-term and continuous monitoring of contaminants in the subsurface environment. This project will develop a novel technology that provides the required sensitivity and selectivity, thus provides just such a means to accomplish this goal.

Rapidly Tunable Optical Filter (DOE 2009 SBIR Phase 2)

Nova Photonics, Inc., Princeton, NJ

Dr. Fred M. Levinton, PI, [flevinton@novaphotonics.com](mailto:flevinton@novaphotonics.com)

DOE Grant No. DE-FG02-08ER85126

\$374,996

Electronically tunable optical filters can provide valuable information in many applications, such as medical sciences, remote sensing, and environmental monitoring. Current optical-filter technology, such as liquid crystal, is limited in switching speed to tens of milliseconds. To achieve a faster response time, this project will design and develop a rapidly-tunable, wide-field, birefringent imaging optical filter with a large aperture. An electro-optic tuning element will allow for fast (~1 msec) switching times. The flexible design will permit bandwidths from ~100 nm to less than 1 nm. High speed tunable imaging filters with a large spatial format can be utilized for multispectral imaging in remote sensing.

Surface NMR Instrumentation and Analysis Methods for Characterizing Vadose Zone Hydrology (DOE 2009 SBIR Phase 2)

Vista Clara Inc., Everett, WA

Dr. David Oliver Walsh, PI, [davewalsh@vista-clara.com](mailto:davewalsh@vista-clara.com)

DOE Grant No. DE-FG02-08ER84979

\$375,000

This project will develop practical field-based measurement and analysis techniques for determining vadose zone transport properties from multi-coil surface NMR measurements. These measurement capabilities would enable more accurate prediction of contaminant transport and aquifer recharge processes. Phase I will (1) demonstrate the theoretical and practical basis for using surface NMR geophysics to detect and characterize vadose zone water, and (2) translate NMR signal properties of vadose zone water into hydraulic properties and/or transport models at the site scale. Phase II will entail full-scale development of vadose-zone surface NMR

instrumentation and analysis methods, coupled with extensive laboratory and field testing at DOE facilities.

## **U.S. Environmental Protection Agency**

Development of an In Situ Thermal Extraction Detection System (TEDS) for Rapid, Accurate, Quantitative Analysis of Environmental Pollutants in the Subsurface (EPA 2010 SBIR Phase 2)

Ion Signature Technology, Inc., North Smithfield, RI

John Moore, 401-767-4360

EPA Contract EPD10062

May 1, 2010 through April 30, 2012

\$224,786

Ion Signature Technology, Inc. (IST) has developed technology to collect VOCs and SVOCs at depth and transport the sample to the surface for analysis without organics adsorbing or condensing in the transfer line. In Phase I, IST found new material to develop a high temperature membrane inlet probe (MIP). When the MIP is at 300 degrees C, organics efficiently desorb and extract from soil. At 100 degrees C, the MIP collects them from groundwater without bringing soil or groundwater to the surface for analysis. In addition, two new freeze traps and a new transfer line gas flow system were designed and tested, which met their respective specifications as established in the objectives. The goal of Phase II is to integrate all of the disparate technologies into a turnkey system so that end users can 'sniff' EPA method 8260 VOCs and 8270 SVOCs as the MIP is advanced into the subsurface at the rate of 2 cm/sec. The thermal extraction and detection system (TEDS) will incorporate electron capture and photoionization sensors to provide real-time, in situ chemical detection of pollutants. Once sensor responses exceed baseline signals, the MIP will stop automatically, with gas flow switching from the sensors to the freeze trap so that pollutants can be concentrated and quantified by GC/MS. All analyses will be made online, at discrete depths, and recorded electronically for upload into site conceptual models.

[http://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9133/report/0](http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9133/report/0)

Distributed Optical Fiber Sensor for Long-term Monitoring of Groundwater Trichloroethylene Levels (EPA 2010 SBIR Phase 1)

Intelligent Optical Systems Inc., Torrance, CA

Manal H. Beshay, 424-263-6300

EPA Contract EPD10030

March 1, 2010 through August 31, 2010

\$70,000

Intelligent Optical Systems, Inc. (IOS) proposes a distributed fiber-optic TCE sensor employing a novel indicator chemistry that will help to overcome the drawbacks historically associated with the Fujiwara indicator. IOS' new approach to TCE monitoring is based on the use of a new colorimetric indicator that has excellent miscibility with IOS' proprietary, highly permeable, UV-light curable optical cladding polymers. The resultant fiber sensor coating, which is highly sensitive to low levels of TCE in water, undergoes color changes from clear (when

unexposed) to deep red (when exposed) to TCE. This distributed optical fiber detection approach meets the required monitoring parameter, and will offer high sensitivity and the simultaneous monitoring of multiple locations. This project will prove the feasibility of using this newly discovered TCE indication in an optical fiber cladding sensor to detect low levels of TCE. The successful results will lead to the development of cost-effective, robust, sensitive, distributed TCE sensors for the remote, long-term monitoring of groundwater.

[http://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9089/report/0](http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9089/report/0)

Handheld Detection System for TCE and PCE (EPA 2010 SBIR Phase 1)

Defiant Technologies, Inc., Albuquerque, NM

Patrick R. Lewis, PI, 505-307-3576, [prlewis@defiant-tech.com](mailto:prlewis@defiant-tech.com)

EPA Contract EPD10021

March 1, 2010 through August 31, 2010

\$70,000

Defiant Technologies will take advantage of microchemical detection technologies recently developed at Sandia National Laboratories to apply them to the development of a handheld sensor system to monitor groundwater. The goal of this effort is a miniature chemical sensor system that will report on groundwater concentration of TCE and PCE in a package that can be adapted for use in even the smallest-bore wells. Defiant's current system can detect TCE and PCE in water at a concentration of 50 ug/L; however, with modifications to the system detector and gas chromatography (GC) column, this system could achieve 1 u/L. In Phase I, Defiant will work on these two components, construct a new high-aspect-ratio micro GC column for use in Phase II, and develop a new MEMs pivot-plate resonator mass detector with associated electronics. By the end of Phase 1, Defiant will have bread-boarded a tortuous path preconcentrator, a micro GC column, and a PPR mass detector, and also will have demonstrated a purge and trap analysis utilizing that technology and a path forward to reach a detection limit of 1 ug/L in Phase II.

[http://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9083/report/0](http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9083/report/0)

Photonic Crystal Slot Waveguide Spectrometer for Monitoring of Volatile Organic Compounds in Groundwater and Hazardous Pollutants in Air (EPA 2010 SBIR Phase 1)

Omega Optics, Inc., Austin, TX

Swapnajit Chakravarty, PI, 512-996-8833

EPA Contract EPD10047

March 1, 2010 through August 31, 2010

\$70,000

Omega Optics, Inc. and the University of Texas, Austin, propose to develop a commercially viable, 100-micron-long silicon lab-on-chip photonic crystal integrated infrared spectrometer for sensing and spectroscopic identification of hazardous materials and pollutants in the environment, specifically VOCs (e.g., BTEX) in drinking water and hazardous air pollutants. The device utilizes the unique dispersive properties of slow light photonic crystal waveguides together with electric-field intensity enhancement in narrow slot waveguides to

achieve a factor 2,000 reduction in absorption length for the spectroscopic measurement of absorption spectra of analytes, specifically hydrocarbons in water and greenhouse gases. By measuring absorption differences in presence and absence of analyte, absorption spectrum of the analyte is determined. The method eliminated the need for labeling for analyte identification. The CMOS compatible platform will ensure high-volume and low-cost production of devices. The potential commercial application of the versatile miniature spectrometer is for any chemical spectroscopy discipline where massively parallel sensing, identification, and high-throughput analysis are desired.

[http://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9105/report/0](http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9105/report/0)

#### Reagentless Field-Usable Fixed-Site and Portable Analyzer for Trihalomethane (THM) Concentrations in Drinking Water (EPA 2010 SBIR Phase 2)

KWJ Engineering, Inc., Newark, CA

Mel Findlay, 510-794-4296

EPA Contract EPD10060

May 1, 2010 through April 30, 2012

\$224,713

In Phase I, KWJ fabricated and tested a MEMS planar version of the sensor, demonstrating the ability to detect less than 5 ppbv  $\text{CHCl}_3$ , less than 15 ppbv  $\text{CHBr}_3$  in gas phase, and less than 10 and 20  $\mu\text{g/L}$ , respectively, in water without pre-concentration. The Phase II research effort will focus on optimizing the sensor and sampler design. KWJ will build, instrument, develop, and validate a simple sensor method with a target of less than 1  $\mu\text{g/L}$  for all THM species. The resulting analyzer will make analytical quality monitoring of drinking water for TTHMs possible virtually anywhere, at any time, on the spot, and at low cost. Additional applications made possible will include pool and spa as well as industrial water and groundwater monitoring.

[http://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9131/report/0](http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9131/report/0)

#### Real-Time Detection and Identification of Chemical, Biological, and Explosive (CBE) Agents with Low False Alarm Rates (EPA 2010 SBIR Phase 1)

Voxtel, Inc., Beaverton, OR

David Schut

EPA Contract EPD10045

March 1, 2010 through August 31, 2010

\$69,996

A Voxtel team has developed a series of CBE taggants composed of metal oxide and semiconductor nanocrystal quantum dots coupled to custom-designed bio(chemical)-functionalized ligand tethers sensitive to a series of CBE agents. CBE-conjugated ligands attach a quenching agent to a nanocrystal emitter, rendering it dark in the absence of a CBE agent. In the presence of a CBE agent, the bioconjugated ligand releases the quenching compound, and a unique optical signature is released that is easily detectable by the eye at short ranges or by LIDAR at longer ranges. The proposed program will demonstrate the sensitivity of the CBE

taggant to CBE agents and characterize the specificity and false alarm rate. In the first tests, the CBE taggant will be distributed via an aerosol dispersant over a contaminated area, and the detection characterized, followed by field demonstrations conducted to demonstrate the ability of these taggants to detect the CBE agent at 2.5 km or more. Leveraging its work in taggants, Voxel proposes to develop a small-sized CBE colorimetric technology that is used as a spray or coating to reveal when an agent is present. The spray visually indicates contaminated areas requiring treatment, which will minimize the time, labor, and material required for decontamination.

[http://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9103/report/0](http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9103/report/0)