

Measurement & Monitoring: 21st Quarterly Literature Update

These references have been added to the literature database developed for the Measurement and Monitoring Technologies for the 21st Century (21M2) website. The searchable archive of abstracts is located at <http://www.clu-in.org/programs/21m2/litsearch.cfm>

Acid Mine Drainage Tracer Tests

Wolkersdorfer, Christian, TU Bergakademie Freiberg, Sachsen, Germany.

7th International Conference on Acid Rock Drainage (ICARD), March 26-30, 2006, St. Louis MO. American Society of Mining and Reclamation (ASMR), Lexington, KY. 12 pp, 2006

Acid mine drainage and the prediction of mine water rebound after mine closure are major problems for the mining industry. Relatively cheap and reliable results for decision-making relative to the hydraulic behavior of the mine water within a mine can be obtained when tracer tests are properly conducted in a flooded mine prior to planning of remediation strategies or numerical simulations. Applying the results of successful tracer tests allows the optimization of remediation designs and diminishes the costs of remediation. The paper summarizes the results of several tracer tests and draws general conclusions from such tests.

Acousto-Optic Differential Optical Absorption Spectroscopy for Atmospheric Measurement of Nitrogen Dioxide in Hong Kong.

Cheng, A.Y. and M.H. Chan, City Univ. of Hong Kong, Kowloon.

Applied Spectroscopy, Vol 58 No 12, p 1462-1468, Dec 2004

Measurement of the atmospheric concentration of nitrogen dioxide was demonstrated by differential optical absorption spectroscopy (DOAS) using a visible acousto-optic tunable filter. A highly stable light source is required in a traditional spectral-scanning DOAS system for atmospheric concentration monitoring. If the light intensity fluctuates during scanning, the concentration retrieval will be inaccurate. To reduce the error due to intensity fluctuations, a modified DOAS system has been developed by introducing a broadband light intensity monitoring channel. Using the measured intensity of the broadband channel as the intensity of the light source, the spectrum can be de-biased and the residual intensity variation will primarily result from atmospheric extinction. By employing a lock-in detection technique, the background light interference is also removed in the modified DOAS system.

Air Pollution Monitoring by Using DOAS Technique

Pucaï, Wang, Wang Gengchen, Guo Xia, Inst. of Atmospheric Physics, CAS, Beijing, China.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

At the Institute of Atmospheric Physics, CAS, three categories of differential optical absorption spectroscopy (DOAS) were recently developed: open-path slant and horizontal paths DOAS that uses the sun as a radiation source; single-end DOAS with infrared He-Ne, CO, and CO₂ lasers as radiation sources; and multi-path DOAS with tungsten and deuterium lamps as a continuous radiation source. The developed DOAS techniques allow monitoring of trace pollution gases, such as CO, NO_x, O₃, CH₄, and C₂H₄ in the near-surface atmosphere. This paper contains technical specifications, proper wavelength selection, advantages and disadvantages of different DOAS systems, monitoring test results, and error analysis.

Air Pollution Monitoring with Two Optical Remote Sensing Techniques in Mexico City
Grutter, M. and E. Flores, Univ. Nacional Autonoma de Mexico.

Remote Sensing of Clouds and the Atmosphere IX. Proceedings of SPIE--The International Society for Optical Engineering, Vol 5571, p 357-363, 2004

An open-path Fourier transform infrared (FTIR) and a differential optical absorption spectrometer (DOAS) were installed and simultaneously operated along a 426 m optical path in downtown Mexico City to measure concentrations of O₃ and SO₂. The measurements generated by both optical remote sensing techniques are presented for comparison. The instruments showed comparable sensitivities for O₃ and an excellent agreement in their correlation. The sensitivity of the infrared technique for SO₂ was limited to concentrations > 20 ppb or so. Benzene and toluene were measured by the DOAS technique and their concentrations over a 3-month period are reported.

http://www.atmosfera.unam.mx/fqa/grutter/papers/Grutter_2004_SPIE_5571.pdf

Air Quality Assessment in an Industrial Area in France Using Monitoring Plants

Rzepka, M.A. and D. Cuny (IEA 2690 Toxiques et Cancerogenes Professionnels et Environnementaux, Lille, France); L. Davranche; F. Cazier; F.O. Denayer; C. Van Haluwyn. ICPEP-3: Proceedings of the Third International Conference on Plants and Environmental Pollution, 29 November - 2 December 2005, Lucknow, India. Book of Abstracts, Abstract SI/O-17, 2005

Sensitive bioindicator plants (tobacco cv. Bel W3 and Bel B; Petunia sp. cv. hybrida F1, Tradescantia sp. clone # 4430) and one accumulator (Brassica oleracea) were exposed in an industrial area in northern France in a 6-month study that extended from May through October. The researchers investigated the use of different biological techniques for environmental impact assessment of ozone and VOCs and compared the results with those obtained with passive samplers, canisters, and an automatic air-pollution network. Fifteen monitoring stations were distributed around the area: 6 near industrial complexes, 5 in rural areas, 3 in urban environments, and 1 greenhouse control. Results from the automatic network showed that ozone pollution was quite homogeneous in each station during the period of experimentation. Data from passive samplers were globally correlated with data from the automatic network. Results from biomonitoring were in agreement with those from the other methods, though micronucleus tests and petunia observations showed greater impacts of pollutants in industrial areas. The combination of bioindicator plants and physico-chemical tools could play an important role in the monitoring of remote areas.

Airborne Emissions of Mercury from Municipal Solid Waste. I: New Measurements from Six Operating Landfills in Florida

Lindberg, S.E., G.R. Southworth, M.A. Bogle, T.J. Blasing, J. Owens, and K. Roy (ORNL, Oak Ridge, TN); H. Zhang and T. Kuiken (Tennessee Tech., Cookeville); J. Price (Florida DEP, Tallahassee, FL); D. Reinhart and H. Sfeir (Univ. of Central Florida, Orlando)
Journal of the Air & Waste Management Association, Vol 55 No 7, July 2005

Using automated flux chambers and downwind atmospheric sampling, researchers quantified the primary pathways of mercury (Hg) vapor releases to the atmosphere at six municipal landfills in Florida. Landfill gas (LFG) was released from active vent systems,

passively from landfill surface covers, and from daily activities at each landfill working face. When the working faces at two sites were spiked with Hg sources, Hg presence was readily detected downwind. Gaseous elemental mercury was released to the atmosphere at readily detectable rates from all sources measured at rates ranging from ~1 to 10 ng/m²/hr over aged landfill cover, from ~8 to 20 mg/hr from landfill gas flares, and from ~200 to 400 mg/hr at the working face. The researchers estimate that atmospheric Hg releases from municipal landfill operations in the state of Florida are on the order of 10 to 50 kg/yr--substantially larger than original estimates, but still a small fraction of current overall anthropogenic losses.

Airborne Multi-Axis DOAS Measurements of Tropospheric SO₂ Plumes in the Po-Valley, Italy
Wang, P., A. Richter, M. Bruns, J. Burrows, W. Junkermann, K.-P. Heue, T. Wagner, U. Platt, and I. Pundt.

Atmospheric Chemistry and Physics Discussions, Vol 5, p 2017-2045, 2005

During the second FORMAT (FORMAldehyde as A Tracer of oxidation in the troposphere) campaign in 2003, the airborne multi-axis DOAS instrument (AMAXDOAS) took spectroscopic measurements of SO₂ from the city of Mantova and a power plant using scattered sunlight during two flights in September. Measurements were performed in 10 different viewing directions, providing information on the vertical SO₂ distribution and the SO₂ vertical column. The airborne measurements results were in good agreement with those of ground-based measurements.

<http://www.copernicus.org/EGU/acp/acpd/5/2017/acpd-5-2017.pdf>

Applicability of Light-Emitting Diodes as Light Sources for Active DOAS Measurements
Kern, C., S. Trick, and J. Zingler (Heidelberg Univ.); D. Pedersen (Hebrew Univ. of Jerusalem); B. Rippel and U. Platt (Heidelberg Univ.).

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

This paper presents the first use of light-emitting diodes (LEDs) as light sources for long-path differential optical absorption spectroscopy (LP-DOAS) measurements of trace gases in the open atmosphere. This instrumentation was used to conduct nitrogen oxide measurements over two major cities. Selected results from these measurements are provided to illustrate measurement and evaluation techniques. The radiative properties of a variety of LEDs are characterized, and parameters such as radiance, spectral shape, spectral range, spectral stability, the influence of environmental factors, and their role in DOAS applications are analyzed. The authors also provide a brief forecast of the future of LED technology and implications for LED-powered DOAS instruments.

Application of a FTUV System to Measure Ambient Pollution in Central Manchester and at Manchester Airport

Cruz-Jimate, I. and M. Bennett, Univ. of Manchester, UK.

Photon 06, 4-7 September 2006, University of Manchester, UK.

A UV-Falcon long-path DOAS system manufactured by Siemens Environmental Systems was used to measure ambient pollution both in Central Manchester and on two field campaigns at Manchester Airport. The system analyzed the UV transmission spectrum between 200 and 270

nm over an open path of approximately 50 m. It routinely measured NO, SO₂, and O₃ and should also be capable of measuring NO₂ with less sensitivity than for the other three gases; however, the system was consistently unreliable for this latter gas in practice. The authors discuss the causes of instrumental problems and methods for overcoming them, with special attention to the feasibility of enhancing spectrometer performance by applying off-line spectral analysis.

<http://www.photon06.org/OPD%20P3.7.doc>

Application of Long-Path Differential Optical Absorption Spectroscopy for 2D-Mapping of Trace Gas Mixing Ratio Near a Highway

Jung, J.S., C.K. Lee, H.L. Lee, J.E. Park, and Y.J. Kim, Gwangju Inst. of Science and Technology (GIST), Gwangju, Korea.

Programme of the Third International DOAS Workshop 2006, Abstract P4-06.

A hybrid method combining algebraic reconstruction technique (ART) and simultaneous iterative reconstruction technique (SIRT) was introduced to reconstruct spatial distribution of trace gas mixing ratio from LP-DOAS based on the path-integrated concentration data and simulation results from CAL3QHC, a line source dispersion model. NO₂ mixing ratio near a highway was measured for a week in October 2004 with a LP-DOAS system over three vertical beam paths at a metropolitan measurement site in Korea. Wind direction was found to be the most sensible parameter for determining ray-integrated concentration values; mixing zone width, mixing height, source height, and surface roughness were also used to determine the dispersion shape. Comparing the measured values with the simulation results, the model underestimated the ray-integrated values ~35% lower than the measured ones, but relative spatial distribution of the integrated concentration values showed good correlation. Line integrated mixing ratios calculated from the reconstructed spatial distribution were very much comparable to the LP-DOAS measured ones. The authors concluded that multiple slant path measurement with the LP-DOAS system can be used to reconstruct the 2-dimensional spatial distribution of trace gas mixing ratio over a line source.

Application of Real Time, On-Line Continuous Monitoring System: On-Site Evaluation of Water-Borne Toxicity in Germany

Kim, Byoung Chan, Jin Hyung Lee, and Man Bock Gu, Advanced Environmental Monitoring Research Center (ADEMRC), Kwangju.

The 4th International Symposium on Advanced Environmental Monitoring, 4-6 December 2002, Jeju, Korea.

Micro-scale bioassays or biosensors that use recombinant or non-modified bioluminescent organisms for detecting and analyzing environmental toxicants are being developed. A continuous water toxicity monitoring system using recombinant bioluminescent bacteria has already been developed and applied to tests of field water toxicity. The system uses genetically engineered bioluminescent bacteria for detection of the potential toxicity of soluble chemicals and accomplishes long-term monitoring. In each channel, different bioluminescent bacteria that respond individually to DNA-, cell membrane-, protein-, oxidative-, or cellular-damaging agents were grown. The bioluminescent levels increase or decrease after mixing with samples suspected to have toxic substances in water. Potential toxicity was monitored at different

field sites in Berlin and in the Rhine River at Worms. At all sites, two channels showed a significant increase in bioluminescence. Though daphnia and algae showed no specific toxic events, the system identified specific toxic events during the test. Though some unexpected results occurred, the feasibility of this system in real field applications was successfully demonstrated. The authors report on the first on-site applications of the multi-channel continuous toxicity monitoring system.

Application of SnO₂ Ceramic Gas Sensor for Monitoring of Effluent Gas from SVE Process
Yang, Ji-Won, Hyun-Jeong Cho, Gwan-Young Choi, Jae-Young Lee, and Moo-Young Kwak,
KAIST, Korea and DreamBios Co., Seoul, Korea.

The 4th International Symposium on Advanced Environmental Monitoring, 4-6 December 2002, Jeju, Korea.

A ceramic gas sensor system has been developed for in situ, on-line monitoring of offgas from a soil vapor extraction (SVE) process. Measuring the concentrations of the extracted vapors provides information concerning the performance and effectiveness of the SVE system. The gas sensor system was designed and constructed cooperatively with a participating company in the ADEMRC project, DreamBios, Korea. This paper describes an assessment of the sensor system.
http://erel.kaist.ac.kr/bbs/view.php?id=publication&page=3&sn1=&divpage=1&sn=off&ss=on&sc=on&select_arrange=subject&desc=asc&no=225

Applications of Solid Phase Microextraction with Ion and Differential Mobility Spectrometry for the Study of Jet Fuels and Organophosphonates

Rearden, Preshious R.A., Ph.D. dissertation, Ohio University, 166 pp, 2006

Solid-phase microextraction (SPME) with ion mobility spectrometry (IMS) was explored for detection of chemical warfare agents in soil using the analytes diisopropyl methylphosphonate (DIMP), diethyl methylphosphonate (DEMP), and dimethyl methylphosphonate (DMMP). A thermal desorption inlet was developed to interface SPME with a hand-held ion mobility spectrometer. SPME/IMS offered good repeatability and detection of the contaminants in soil at concentrations as low as 10 ug/g. Jet fuels and VOCs (benzene, m-xylene, p-xylene, toluene, and MTBE) were examined by gas chromatography/differential mobility spectrometry (GC/DMS). A micromachined differential mobility spectrometer with a 10.6 eV photoionization source was used as the GC detector. GC/DMS produces second-order data that is applicable to chemometric analysis. Savitzky-Golay filters were explored as a tool for data smoothing of jet fuel data obtained with GC/DMS. Covariance maps were proposed for data visualization. Improved chromatographic resolution and signal-to-noise ratios were achieved with Savitzky-Golay filters. The fuzzy rule-building expert system (FuRES) was used as a pattern recognition method to classify gas chromatograms of fuels. Variations in day-to-day sample collection were evaluated with analysis of variance-principal component analysis (ANOVA-PCA). Simple-to-use interactive self-modeling mixture analysis (SIMPLISMA) and alternating least squares (ALS) proved to be suitable tools to model GC/DMS data, modeling all components in a mixture of BTX and MTBE and resolving xylene isomers that co-eluted.
http://www.ohiolink.edu/etd/view.cgi?acc_num=ohiou1142627911

Applying Open-Path FTIR with Computed Tomography to Evaluate Personal Exposures. Part 1: Simulation Studies

Wu, Chang-Fu and M.G. Yost (Univ. of Washington, Seattle); R. Hashmonay (ARCADIS, Research Triangle Park, NC); T.V. Larson (Univ. of Washington); S.E. Guffey (West Virginia Univ., Morgantown).

Annals of Occupational Hygiene, Vol 49 No 1, p 61-71, Jan 2005

The authors discuss the theoretical background and the numerical evaluation results obtained using computed tomography coupled with open-path Fourier transform infrared (CT-FTIR) measurements to estimate personal exposures. One-dimensional and two-dimensional scenarios were tested in simulation studies with results that support the feasibility of using the CT-FTIR approach for industrial hygiene monitoring.

Applying Open-Path FTIR with Computed Tomography to Evaluate Personal Exposures. Part 2: Experimental Studies

Wu, Chang-Fu and M.G. Yost (Univ. of Washington, Seattle); R. Hashmonay (ARCADIS, Research Triangle Park, NC); T.V. Larson (Univ. of Washington, Seattle).

Annals of Occupational Hygiene, Vol 49 No 1, p 73-83, Jan 2005

Computed tomography coupled with OP-FTIR (CT-FTIR) measurement was tested for the estimation of personal exposures to carbon monoxide. Experimental data were collected inside a ventilation chamber from a personal sampling device attached to a remotely controlled robot. While the robot moved inside the chamber, a tracer gas was released from a line source. The estimated personal exposures were calculated from both the area sampling array data and the CT-FTIR measurements, plus information about the robot's locations in real time. Based on the sensitivity and specificity analysis of the experimental data, the suitability of this approach as a warning system was demonstrated.

Arsenic Speciation Analysis in Water Samples: A Review of the Hyphenated Techniques

Terlecka, Ewa, Inst. of Meteorology and Water Management, Wroclaw, Poland.

Environmental Monitoring and Assessment, Vol 107 Nos 1-3, p 259-284, Aug 2005

The toxic effects of arsenic are connected to its chemical forms and oxidation states. This article provides information about the occurrence of the dominant arsenic forms in various water environments, accompanied by a discussion of the main factors controlling arsenic speciation in water. The quantification of species is difficult because the concentrations of different forms in water samples are relatively low compared to the detection limits of the available analytical techniques. Several hyphenated methods used in arsenic speciation analysis are described, with explanations of specific advantages and disadvantages of methods that can define their application for a particular sample analysis. Suggestions are made for methods improvement and modification.

Assessment of Aromatic Compounds by Whole-Cell Biosensors and SPR-Based DNA Chips
Park, H. and S.M. Park (Pusan National Univ., Busan, Korea); H.J. Shin (Dongseo Univ., Busan, Korea).

The 4th International Symposium on Advanced Environmental Monitoring, 4-6 December 2002, Jeju, Korea

Whole-cell biosensors and SPR (surface plasmon resonance)-based DNA chips were developed for the detection of toxic aromatic compounds, such as phenol, salicylate, and BTEX. Regulatory protein (NahR, CapR, and XylR) encoding genes and their operating promoters were cloned by PCR from *Pseudomonas putida*. Firefly luciferase (*luc*), beta-galactosidase (*lacZ*) and green fluorescence protein (*gfp*) as reporter genes were used to construct plasmids that are controlled by the regulatory protein genes and the promoters. In tests, these novel devices were used to assess pure chemicals and sewage, and the results were compared to chemical and GC analysis. The whole-cell biosensors were able to quantify accurately with minimum detection limits of 0.5-1 μM without any pretreatment of samples. The SPR-based optical biosensor DNA chip (Biacore 3000) was used for a real-time assay with increased sensitivity. The authors discuss the applicability of the Biacore in monitoring specific environmental pollutants in a real time.

Atomic Mercury Flux Monitoring Using and Optical Parametric Oscillator Based Lidar System
Sjoeholm, M., P. Weibring, H. Edner, and S. Svanberg, Lund Inst. of Technology, Lund, Sweden.

Optics Express, Vol 12 No 4, p 551-556, Feb 2004

A newly developed optical parametric oscillator (OPO)-based differential absorption lidar (DIAL) system was used to monitor atomic mercury emissions at several chlor-alkali plants in Europe. The versatility of the system was illustrated by measured time series of mercury flux and movies of vertical and horizontal concentration distributions. The authors discuss approaches to meet the special demands (e.g., long-term stability) of the light source. [Click on the "View Full Text" link for the paper.]

<http://www.opticsexpress.org/abstract.cfm?URI=OPEX-12-4-551>

Auto-Max DOAS: a New Measurement Platform

Ibrahim, O.W., T. Stein, T. Wagner, and U. Platt, Heidelberg Univ., Heidelberg, Germany.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

Measurements of tropospheric and stratospheric trace gases using the multi axes-differential optical absorption spectroscopy (MAX-DOAS) technique are now widely used. In addition to stationary ground-based applications, MAX-DOAS instruments can be mounted on mobile platforms (satellites, planes, ships). This paper describes the results of measurements taken via a small MAX-DOAS instrument mounted on an automobile to assess NO₂ from an industrial area, a heating facility, and a power plant. As expected, results showed elevated slant column densities (SCDs) of NO₂ downwind from the source areas. This new platform allows measurements to be taken quickly as the vehicle circles around well-defined targeted pollution sources to estimate the in-flux and out-flux of tropospheric pollutants. The Auto-MAX measurements provide better spatial resolution those of satellites and airplanes for city air pollution. Improvements to the temporal resolution of the integration time of the Auto-MAX

spectrometer will improve its spatial resolution to the order of tens of meters, which will allow measurements of polluted air masses in a city or of a single plume.

Bacterial Bioassay for Rapid and Accurate Analysis of Arsenic in Highly Variable Groundwater Samples

Trang, P.T.K. (Hanoi Univ. of Science, Vietnam); M. Berg (Swiss Federal Inst. of Aquatic Science and Technology); P.H. Viet; N.V. Mui; J.R. van der Meer.

Environmental Science & Technology, Vol 39 No , p 7625-7630, 2005

The authors report the first-ever, large-scale environmental validation of a microbial reporter-based test to measure arsenic concentrations in natural water. A bioluminescence-producing, arsenic-inducible bacterium based on *Escherichia coli* was used as the reporter organism. Specific protocols were developed to avoid the negative influence of iron in groundwater on arsenic availability to the bioreporter cells. The bacterial cells performed well at and above arsenic groundwater concentrations of 7 ug/L, with an almost linearly proportional increase of the bioluminescence signal between 10 and 100 ug As/L ($r^2 = 0.997$). Comparisons between atomic absorption spectroscopy (AAS) and arsenic bioreporter determinations gave an overall average of 8.0% false negative and 2.4% false positive identifications for the bioreporter prediction at the WHO-recommended acceptable arsenic concentration of 10 ug/L, which is far better than the performance of chemical field test kits. Because of the ease of the measurement protocol and the low application cost, the microbiological arsenic test has great potential for large screening campaigns.

<http://instructional1.calstatela.edu/ckhachi/REU/Projects/Arsenic/Biosensor/van%20der%20Meer%203.pdf>

Benthic Flux Sampling Device Tool

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 25 pp, Oct 2004

The Benthic Flux Sampling Device 2 (BFSD2) is a remotely operated instrument for in situ measurement of the exchange rate of contaminants and other biochemical compounds across the sediment/water interface. Information on flux rates is used in evaluating the risks posed by in-place sediment contamination. This Web Tool provides background information on the operation and capabilities of BFSD2, including a deployment video. Example results are also discussed from two Navy sites where BFSD2 has been deployed to investigate the extent of metals and organics impact in coastal sediments.

<http://www.ert2.org/ert2portal/DesktopDefault.aspx>

Benzene Air Monitoring in Corio 2003-2005

EPA Victoria, Australia. Environmental Report No 999, 8 pp, 2005

Air monitoring in Corio, Victoria, Australia, was accomplished using two different methods: weekly canister sampling to allow the calculation of average benzene levels for comparison with the annual National Investigation Levels, and continuous sampling to provide hourly benzene levels for comparison with the Victorian Intervention Level. Continuous monitoring has been conducted at a school close to the canister site since January 2003 using a

UV-visible spectrometer and the technique of differential optical absorption spectrometry (DOAS). The technique involves passing a light beam over a distance of 430 meters from a light source to a receiver. The amount of absorption of light energy at specific wavelengths corresponds to the concentration of the compound. The monitoring equipment was installed at the school approximately 500 meters due east of a refinery site. Benzene results for hourly averages from continuous monitoring are considered to be accurate to +/-5 ug/m³. The instrument was calibrated monthly using a reference gas standard. Concentrations were retrieved from the analyzer as five-minute averages and converted to one-hour average concentrations (based on clock hours in accordance with national procedures -- using non-clock hours can lead to somewhat higher or lower concentrations). Results associated with instrument light intensity of 5% or above were considered valid data. These concentrations were compared against the benzene Intervention Level.

[http://epanote2.epa.vic.gov.au/EPA/publications.nsf/d85500a0d7f5f07b4a2565d1002268f3/cedc b7ec217f5842ca256ffe00818bab/\\$FILE/999.pdf](http://epanote2.epa.vic.gov.au/EPA/publications.nsf/d85500a0d7f5f07b4a2565d1002268f3/cedc b7ec217f5842ca256ffe00818bab/$FILE/999.pdf)

Biomonitoring of Air Quality Using Plants

Mulgrew, Angela and Peter Williams, MARC, King's College, London.

WHO Collaborating Centre for Air Quality Management and Air Pollution Control, German Federal Environmental Agency, Berlin. Air Hygiene Report no. 10, 2000

This review divides each chapter by pollutant type--metals and gaseous and organic compounds--because the methods used are generally dependent on the type of pollution under investigation. Heavy metals are generally non-acidic particulates, such as lead and zinc. Gaseous pollutants included nitrogen oxides, sulfur dioxide, ozone (volatile organic compounds and nitrogen oxides, once emitted, undergo chemical transformation in the atmosphere in the presence of sunlight to form ozone), and fluoride. Organic and synthetic chemicals include substances such as dioxins, polycyclic aromatic hydrocarbons, and organochlorines. Radionuclides and the indirect impact of air pollution--acidification of soil and water--are not evaluated. Each chapter is subdivided into plant groups. The review includes all plant species that are currently or the have potential of being used as biomonitors/bioindicators of air pollution, e.g., lichens, bryophytes (mosses), higher plants (trees, shrubs, crops), algae, and fungi. Where applicable, comments on monitoring design are included in each section. The review focuses exclusively on terrestrial environments, omitting freshwater or marine habitats.

<http://www.umweltbundesamt.de/whocc/AHR10/content2.htm>

Biomonitoring of Sulfur and Heavy Metals Around a Coal-Fired Thermal Power Plant

Sharma, A.P., S. Pandey, S. Prajapati, and B.D. Tripathi, Banaras Hindu Univ., Varanasi, India. ICPEP-3: Proceedings of the Third International Conference on Plants and Environmental Pollution, 29 November - 2 December 2005, Lucknow, India. Book of Abstracts, p 18, abstract SI/P-26, 2005

Biomonitoring investigations of sulfur and heavy metals from a thermal power plant in India were conducted at different locations within a 15 km range. The leaves of *Ficus religiosa*, *F. benghalensis*, *Mangifera indica* and *Azadirachta indica* trees were used to observe the dispersion of fugitive emissions from the power plant and the impact on surrounding vegetation. The results have shown that the contaminating agents are dense and effective, particularly in the

prevailing wind direction and within 15 km range. Contaminating agents or fugitive emissions gradually lose their density and impact beyond this range. Analyses of soil samples for sulfur and heavy metals from the same locations showed similar findings with the data obtained from the leaves.

Capillary Electrophoresis Single-Strand Conformation Polymorphism Analysis for Monitoring Bacteria during the Remediation of TNT-Contaminated Soil

King, Stephanie, Ph.D. dissertation, Ohio University, 123 pp, 2004

The ability to monitor a microbial community effectively is necessary to design and implement remediation strategies for contaminated soil. Single-strand conformation polymorphism (SSCP), a technique that separates DNA fragments based on their sequence, was used to analyze PCR-amplified 16S ribosomal RNA gene fragments of common soil bacteria. Separation was performed using capillary electrophoresis (CE), rather than other common gel techniques, to eliminate the need for band analysis on gel matrices. CE-SSCP was used to analyze bacteria in pure culture and soil and to monitor an introduced species. By combining multiple universal primer sets, 12 common soil bacteria in pure culture could be separated. Studies to determine microbial community fingerprints and track species of interest in soil were also performed. The DNA extracted from the soil needed to be diluted before amplification to reduce the inhibiting effects of humic acids that co-extract with the soil DNA. Results of the bacteria spiking studies revealed that high concentrations of the introduced species were necessary for identification. When monitoring inoculated bacteria for phytoremediation studies, a shift in the native profile was observed in contaminated soil. It is possible that the introduced species with TNT-remediation capabilities were observed in the explosive-containing samples, though additional studies must be performed to confirm these results. The final step was to design a primer set specific for the TNT-reducing bacteria used for the phytoremediation study. Preliminary results with agarose gel electrophoresis showed that the designed primer set was selective for the genus, but not the species of interest.

http://www.ohiolink.edu/etd/view.cgi?acc_num=ohiou1108061640

A Case Study of Dioxin Monitoring in and Around an Industrial Waste Incinerator

Kim, Byung-Hoon, Se-Jin Lee, Hee-Sun Kim, Su-Jung Mun, and Yoon-Seok Chang, Pohang Univ. of Science and Technology, Pohang, Korea.

The 4th International Symposium on Advanced Environmental Monitoring, 4-6 December 2002, Jeju, Korea.

Polychlorinated dibenzo-p-dioxins/dibenzofurans (PCDD/Fs) are known to form during incineration process, as well as through natural processes such as forest fire. There are 75 different PCDDs and 135 different PCDFs. There are 17 congeners having toxic equivalent factors among the 2,3,7,8-substituted congeners. Different sources of PCDD/Fs are characterized by different congener patterns. The comparison of the 17 congener profiles was found to be useful in methods of defining the distribution and relationship of PCDD/Fs in diverse environmental matrices in and around an industrial hazardous waste incinerator.

Characterization of Mercury Emissions at a Chlor-Alkali Plant

U.S. EPA, Office of Research and Development. EPA 600-R-02-007, 709 pp, Jan 2002

Current estimates indicate that up to 160 short tons (146 Mg) of mercury (Hg) are consumed by the chlor-alkali industry each year, but little quantitative information is currently available on the actual Hg losses from these facilities. The Hg cell building roof vent is considered to be the most significant potential emission point in chlor-alkali plants, especially when the cells are opened for maintenance. Because of their potential importance, chlor-alkali plants have been identified as needing more accurate measurements of Hg emissions. To obtain a better understanding of the fate of Hg within their manufacturing process, the Olin Corporation voluntarily agreed to cooperate with U.S. EPA in a comprehensive study of the Hg emissions from their Augusta, GA, facility, in collaboration with other members of the Chlorine Institute representing the active chlor-alkali plants in the United States. To investigate the Hg releases from the Olin chlor-alkali facility, EPA organized a special study involving multiple organizations and personnel. The overall objective of monitoring the cell building roof vent was to determine the total elemental mercury (Hg(0)) mass flux from the cell building under a range of typical wintertime meteorological conditions, including both normal operation of the cell building and routine maintenance of Hg cells and decomposers. Secondary objectives of the research were to perform an air flow mass balance for the building and to compare various Hg monitoring methods under a variety of sampling conditions. Both objectives were met during the February 2000 field sampling campaign, which showed an average Hg(0) emission rate of 0.36 g/min from the roof ventilator as determined over the 9-day monitoring period.

<http://www.epa.gov/ORD/NRMRL/pubs/600r02007/600r02007.htm>

A Chemical Sensor for Chloromethanes Using a Nanocomposite of Multiwalled Carbon Nanotubes with Poly(3-Methylthiophene)

Santhanam, K.S.V., Rajiv Sangoi, and L. Fuller, Rochester Inst. of Technology, Rochester, NY. Sensors and Actuators B: Chemical, Vol 106 No 2, p 177-184, 14 Sep 2005

Scientists constructed a vapor-phase chemical sensor with a viewing area of 0.78 mm² (diameter 1 mm) using a novel nanocomposite material comprising multiwalled carbon nanotubes and poly (3-methylthiophene) that shows a change in electrical resistance upon exposure to different chloromethanes. The resistance change is proportional to the concentration of the analyte. The sensor is capable of selectivity to any mixture made up of chloromethane and methane at a typical response time of 60 to 120 seconds; it does not respond to methane, acetone, acetaldehyde, benzaldehyde, tetrahydrofuran, methanol, or ethanol.

Chemometric Study of Polycyclic Aromatic Hydrocarbons in Soils of the Chattanooga Creek Floodplain

Wells, M.J.M. (Tennessee Tech, Cookeville); J.C. Tucker and M. Belka (Univ. of Tennessee at Chattanooga).

The 231st ACS National Meeting, Atlanta, GA, March 26-30, 2006, ENVR 63

Sixteen priority pollutant polycyclic aromatic hydrocarbons (PAHs) were monitored in surface soils of the Chattanooga Creek floodplain. The Visual Sampling Plan (VSP) computer program was applied to develop a random sampling approach for an area of approximately 127,500 square feet. The VSP program was used to determine the number of samples needed and

to generate a geographic coordinate system to identify sampling locations. PAH-specific enzyme-linked immunosorbent assay procedures were used to screen 59 soil samples, and selected samples were further investigated using gas chromatography-mass spectrometry (GC-MS). A multivariate examination of relationships among the data was conducted using statistical analysis system principal component analysis to differentiate the distribution of PAH occurrence among the sites sampled.

CLICK: The New USGS Center for Lidar Information Coordination and Knowledge
Stoker, J.M. (SAIC); S.K. Greenlee and D.B. Gesch (USGS); J.C. Menig (SAIC).
Journal of the American Society for Photogrammetry and Remote Sensing, Vol 72 No 6, p 613-616, June 2006

Light detection and ranging (lidar) has been increasingly accepted as an effective and accurate technology for acquiring high-resolution elevation data for bare earth, vegetation, and structures. Lidar is an active remote sensing system that records the distance or range of a laser fired from an airborne or space-borne platform--airplane, helicopter, or satellite--to objects or features on the Earth's surface. By converting lidar data into bare ground topography and vegetation or structural morphologic information, extremely accurate, high-resolution elevation models can be derived to visualize and quantitatively represent scenes in three dimensions. Standardized methods for processing lidar data do not exist because of different lidar system configurations, desired applications, and improvements in the system technology, computer processing power, and memory. Key differences among lidar system configurations include wavelength, power, pulse duration, repetition rate, beam size and divergence, angle, scanning mechanics, and information recorded for each reflected pulse. As a result, different commercial vendors use different processing methods depending on these factors, some of which are proprietary. New off-the-shelf techniques and methods continue to become available as computing power and lidar system capabilities increase. The three broad application categories using lidar data involve bare earth analyses, vegetation analyses, and urban analyses. The U.S. Geological Society has developed the virtual Center for Lidar Information, Coordination and Knowledge (CLICK, <http://lidar.cr.usgs.gov>) in an attempt to improve data availability, knowledge, access, and user information especially for scientific applications for unfiltered point cloud datasets across the country. By providing a virtual center where people interested in lidar remote sensing can come, ask and answer questions, download data, and coordinate with other users, the USGS hopes that innovations in lidar-related research will increase significantly. By providing an access point for locating and downloading existing lidar datasets, redundancy in collections may be reduced, thus reducing unnecessary expenditures for additional lidar data collections.

<http://www.asprs.org/publications/pers/2006journal/june/>

A Combined Analytical Study to Characterize Uranium Soil and Sediment Contamination: The Case of the Naturita UMTRA Site and the Role of Grain Coatings

Jove Colon, C.F. (Sandia National Labs); C. Sanpawanichakit (Colorado School of Mines); H. Xu (Univ. of New Mexico); R.T. Cygan (SNL); J.A. Davis and D.M. Meece (USGS); R.L. Hervig (Arizona State Univ.).

U.S. Nuclear Regulatory Commission, NUREG/CR-6898, 48 pp, Feb 2006

Composite sediment samples from the Uranium Mill Tailings Remedial Action site at Naturita, CO, were analyzed for uranium using a suite of microbeam analytical techniques encompassing scanning electron microscopy-energy dispersive spectrometry (SEM-EDS), secondary ion mass spectrometry (SIMS), high resolution transmission electron microscopy (HRTEM), micro-synchrotron x-ray fluorescence (M-SXRF), and micro-x-ray absorption near-edge spectroscopy (M-XANES). Two sets of alluvial sediment samples were considered in this study: an untreated composite sediment sampled from several uranium-contaminated wells, and a carbonate-free (treated) composite sediment from an area significantly upgradient from the contaminated portion of the site. The bulk grains that serve as substrate to the overlying coatings are mostly quartz and detrital feldspar. The Fe-rich coatings are arranged conformably in both continuous and discontinuous modes, in some cases between the quartz interface and the clay-rich region, but Fe-rich phases are also present as small scattered particles immersed in the clay layer. SIMS analysis on polished epoxy grain mounts of the naturally-contaminated composite sample reveals the presence of U diffusely distributed within the Al-Si rich clay layer. No clear association between Fe and U from materials collected in sampling wells with the highest level of U contamination was discerned using this analytical technique; however, M-SXRF analyses on the laboratory-contaminated carbonate-free sample reveals a close association between U and Fe-rich domains on the grain surface. HRTEM analysis on a single grain from the carbonate-free sample characterized by this strong U/Fe spatial correlation indicate that these Fe-bearing phases are highly heterogeneous, composed mainly of mixed domains of hematite, goethite, and nanoporous and/or amorphous Fe-(oxy)hydroxides. These Fe-rich nanoporous and amorphous domains within larger Fe-bearing grains are identified as ferrihydrite on the basis of HRTEM observations. The arrangement of Fe-rich amorphous phase domains along with crystalline goethite resembles aggregated textural forms, but HRTEM analysis indicates that these domains are structurally coherent and continuous, suggesting homogeneous transformation. Mixed layer illite/smectite clays are to a great extent the main coating phases present hosting nanosized Fe and Ti oxides. On the basis of these combined analytical observations, mixed-layer clays and Fe-rich coatings are the main sinks for U in the composite sediment material at Naturita.

<http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6898/>

Combined Probes for Sub-Millimetric Investigations in Aquatic Sediments

Jezequel, D., E. Metzger, E. Viollier, and F. Prevoit (Laboratoire de Geochemie des Eaux & IPGP); R. Brayner and F. Fievet (ITODYS Univ. Paris 7, France).

The 15th Annual Goldschmidt Conference, 2005: Abstracts, A59, 2005

The sediment/water interface (SWI) of aquatic environments is a very reactive zone involving strong gradients for dissolved compounds. Thin-films hydrogel techniques introduced in early 1990s are well adapted for 2-D studies of such media. A new combined DET/DGT probe able to provide information both on iron and sulfide 2D distributions was tested. After in situ deployment of the probe in a Mediterranean lagoon, a reactive soaked gel with Ferrozine was applied on the DET gel layer and a magenta color appeared within minutes in rich ferrous iron zones. Sulfide distribution information was obtained with a DGT-like device: a PVC reactive film located behind the DET layer in the probe. The PVC film shows gray in the H₂S rich zone of the sediment. Densitometry analysis after scanning produces quantification of FeII distribution and qualitative information of sulfide distribution. For 1-D investigations we have developed a

A double-side probe has been developed for 1-D investigations that uses a DGT for one face and a DET for the second face to compare Cd measurements with minor components, such as Fe and Mn, minimizing spatial effects in heterogeneous sediment. Trace elements are analyzed by ICP-AES, ICP-MS, and GF-AAS. The DGT face can be analyzed by LA-ICP-MS to get 2-D distribution of trace metals. The technique support several combinations of thin films and analytical techniques.

Comparison of 24 h Averaged VOC Monitoring Results for Residential Indoor and Outdoor Air Using Carbopack X-Filled Diffusive Samplers and Active Sampling: a Pilot Study
McClenny, W.A., H.H. Jacumin Jr., K.D. Oliver, E.H. Daughtrey Jr., and D.A. Whitaker.
Journal of Environmental Monitoring, Vol 8, 263-269, 2006

Analytical results obtained by thermal desorption GC/MS for 24 h diffusive sampling of 11 VOCs--Freon 11, 1,3-butadiene, benzene, toluene, tetrachloroethene, ethylbenzene, m,p-xylene, o-xylene, 4-ethyltoluene, 1,3,5-trimethylbenzene, and p-dichlorobenzene--were compared with results of time-averaged active sampling at a known constant flow rate. Air samples were collected with co-located duplicate diffusive sampling tubes and one passivated canister in eight multiple-component sampling events at fixed positions inside and outside three private homes. Agreement between the two sampling approaches shows that the prediction of approximately constant diffusive sampling rates based on previous laboratory studies is valid under the field conditions.

Comparison of BTX Measurements Using a Differential Optical Absorption Spectroscopy and an On-Line Gas Chromatography System
Kim, K.-H., Sejong Univ. Seoul, Korea.
Environmental Engineering Science, Vol 21 No 2. p 181-194, Mar 2004

The suitability of the DOAS system for the analysis of aromatic VOCs (e.g., benzene, toluene, and xylenes) in air was tested against an on-line GC measurement technique. The compatibility between the two different methodologies, when checked in terms of various standards, was found to vary considerably, depending on species. A comparison of the data sets obtained by the two systems reveals that toluene was most compatible between the two systems, while benzene displayed the least agreement. Though the system-to-system bias differs with the chemical species, the overall study results suggest that the use of the commercial DOAS system can provide reliable information of temporal and spatial distribution patterns of major aromatic VOCs, depending on their concentration levels in ambient air.

A Comparison of Cu, Pb, As, Cd, Zn, Fe, Ni and Mn Determined by Acid Extraction/ICP-OES and Ex Situ Field Portable X-Ray Fluorescence Analyses
Kilbride, C., J. Poole, and T.R. Hutchings, Forest Research Land Regeneration and Urban Greening Group, Farnham, Surrey, UK
Environmental Pollution, Vol 143 No 1, p 16-23, Sep 2006

Two types of field-portable X-ray fluorescence (FPXRF) system--dual isotope and X-ray tube--were used to determine total concentrations of Cu, Pb, As, Cd, Zn, Fe, Ni, and Mn in 81 soil samples. FPXRF metal concentrations were statistically compared with analytical results

from aqua regia extractions followed by inductively coupled plasma/optical emission spectrometry analysis. A high degree of linearity was observed for Fe and Pb with the X-ray tube instrument and for Fe, Cu, Pb, Zn, Cd, and Mn with the dual-source instrument. Increased analysis time improved FPXRF analyzer performance for Cu, Mn and Pb, while Fe, Zn, Cd, Ni, and As showed no significant improvement. Particle size did not influence FPXRF analyzer performance. Both the dual isotope and the X-ray tube FPXRF instruments can provide for rapid, quantitative assessment of soil metal contamination and for monitoring the efficacy of remediation strategies.

Comparison of Porewater Sampling Methods and Evaluation of a Voltammetric Microelectrode to Characterize Natural Attenuation in Wetlands

Lorah, Michelle M., David R. Burris, and Linda Jo Dyer.

Natural Attenuation of Chlorinated Solvent Ground-Water Plumes Discharging into Wetlands.

U.S. Geological Survey Scientific Investigations Report 2004-5220, Section 3, p 3.1-3.31, 2005

Determining the fate of contaminants in wetland groundwater requires the collection of samples at discrete, closely spaced depth intervals with devices that can be installed and sampled with light and portable equipment. Results for the sampling and analytical methods that were tested were used in development of a protocol addendum for the assessment of natural attenuation of chlorinated solvent plumes discharging into wetlands

<http://pubs.usgs.gov/sir/2004/5220/pdf/sir-2004-5220.pdf>

Concentration and Fate of Persistent Organochlorine Pesticides in Estuarine Sediments Using Headspace Solid-Phase Microextraction

Chang, Sue-Min (National Chiao Tung Univ., Hsinchu, Taiwan, ROC); Ruey-an Doong

(National Tsing Hua Univ., Hsinchu, Taiwan, ROC).

Chemosphere, Vol 62 No 11, p 1869-1878, Mar 2006

The concentration and fate of persistent organochlorine pesticides (OCPs) in estuarine surface sediments were investigated using headspace solid-phase microextraction (HSSPME) to evaluate the pollution potential. The HSSPME method exhibits a good analytical performance with low detection limits for OCP determination in sediment. Results obtained using the developed HSSPME method agreed well with those obtained using Soxhlet extraction in a certified sample. HCHs and DDT were abundant in the estuarine sediments from the selected rivers. The investigation shows that the origin of OCPs in the surface sediments from Erh-Jen River is a combination of erosion of the weathered soils and long-range atmospheric transport, while the concentrations found in Lan-Yang River could be regarded as the background levels of OCPs in Taiwan.

Construction of Biosensors with the Gene Promoters of Pseudomonas sp. DJ-12 Responding upon Exposure to the Aromatics

Park, Sang-Ho, Sung-Bin Lim, and Chi-Kyung Kim, Genopia Co. Ltd., Daejeon, Korea, and Chungbuk National Univ., Cheongju, Korea.

The 4th International Symposium on Advanced Environmental Monitoring, 4-6 December 2002, Jeju, Korea.

Pseudomonas sp. DJ-12 degraded biphenyl and 4CB at concentrations of 3 to 7mM within 18 hours incubation, and 4HBA at 3 to 7 mM concentrations was rapidly degraded even after 30 hours. Several stress proteins, such as DnaK, were commonly induced when the cells were addressed with each aromatic. The bacterial biosensors were constructed to detect aromatic pollutants by a transcriptional fusion method using promoters of the pcbDC gene or dnaK gene and several reporter genes. The cells of *E. coli* XL1-Blue carrying the respective gene fusions pcbDCp::luc, pcbDCp::lux, and pcbDCp::gfp were compared for bioluminescence production by exposing them to 2,3-dihydroxybiphenyl (2,3-DHBP) and catecholic compounds. The maximum light production was seen at 70 min when exposed to 0.5 mM and 1 mM 2,3-DHBP. The bioluminescence by pcbDCp::lux fusion was broadly expressed to catechol and 4-chlorocatechol at various concentrations. The biosensor bacteria harboring pcbDCp::gfpuv fusion did not respond to 4-chlorocatechol. The degree of light production by the biosensor containing dnaKp-DJ::lux fusion was greater than that of the biosensor containing dnaKp-DJ::luc fusions. The bacterial biosensors constructed using the dnaK promoter of *Pseudomonas* sp. DJ-12 and lux marker gene were more sensitive than those with the pcbDC promoter. These biosensors show great potential for use in monitoring certain types of aromatic pollutants.

Contamination Characterization through Airborne Hyperspectral Imagery: Pilot Project
Missouri Department of Natural Resources (DNR) and U.S. Environmental Protection Agency (U.S. EPA). Site Development Workshop: April 7, 2005

The Missouri Department of Natural Resources received an EPA Office of Solid Waste and Emergency Response (OSWER) grant for a pilot project to evaluate hyperspectral imagery (HSI) applications for characterizing chemical contamination. The project identifies and evaluates potential applications of the Civil Air Patrol's (CAP) new hyperspectral imagery (HSI) airborne sensor to real-time support for the department's Environmental Emergency Response (EER) and local emergency responders, wide-area characterization or field screening of chemical contamination and analysis of other environmental problems. CAP's HSI system, Airborne Real-Time Cueing Hyperspectral Enhanced Reconnaissance (ARCHER), will be deployed in 16 locations around the continental U.S. in mid-to-late 2005. The pilot project is in the early stages of identifying potential environmental applications for evaluation and developing a database of sites for HSI collection. On April 7, 2005, the department held a Site Development Workshop for federal and state agencies to exchange information on requirements and potential applications of HSI with ARCHER's project personnel. The workshop included a briefing on EPA's Airborne Spectral Photometric Environmental Collection Technology (ASPECT) system. ASPECT is a multi-spectral infrared imaging system that characterizes airborne contaminant plumes. The overall objective of the project is to identify environmental applications for CAP's HSI sensor, and commercial HSI sensors, collect imagery of known contaminated sites using CAP's system, or a commercial airborne sensor with a similar spectral range, develop spectral signatures of the contamination, and assess proposed applications. The Project will also identify collection and analysis procedures that can be used with future CAP flights. Applications characterizing chemical contamination in support of real-time EER would be the highest priority. Other applications for wide area field screening or characterizing contaminated sites, assessing levels of contamination and determining the use of vegetation stress as an indicator of contamination will be evaluated, to the extent funding allows.

<http://dnr.mo.gov/env/hwp/hsi/workshop-report.pdf>

Correlation Study Between Suspended Particulate Matter and DOAS Data

Si, F., J. Liu, P. Xie, Y. Zhang, and W. Liu (Chinese Academy of Sciences, Hefei); H. Kuze, N. Lagrosas, and N. Takeuchi (Chiba Univ., Japan).

Advances in Atmospheric Sciences, Vol 23 No 3, p 461-467, May 2006

Differential optical absorption spectroscopy (DOAS) is a very useful tool for the simultaneous detection of gases and particles in studies on heterogeneous chemistry. Major tropospheric aerosol types include sulfate, dust, organic carbon, black carbon, and sea salt aerosols. The Mie-scattering arising from these particles can be detected by DOAS. In fact, when aerosol extinction coefficients measured by DOAS are correlated with the suspended particulate matter amount (SPM), a strong correlation can often be found between the two quantities. The aim of this paper is threefold. First, the authors examine the DOAS data during one month (December 2003 to January 2004) in Kyoto, Japan, to study the correlation with the SPM data. Second, simulation and experimental results show that mass extinction efficiency (MEE) values generally decrease due to the increased concentration of aerosols with larger diameters. Finally, the MEE values are computed using the DOAS data and the ground sampling data, and the relationship between the MEE parameter and relative humidity is discussed.

<http://www.iap.ac.cn/html/qikan/aas/aas2006/200603/233sfq.pdf>

Decision Support Tools for Evaluation and Selection of Technologies for Soil Remediation and Disposal of Halogenated Waste

Khelifi, O., S. Zinovyev, A. Lodolo, S. Vranes, and S. Miertus, ICS-UNIDO, Trieste.

DIOXIN 2004: 24th International Symposium on Halogenated Environmental Organic Pollutants and Persistent Organic Pollutants (POPs), 6-10 September 2004, Berlin, Germany.

Organohalogen Compounds. Vol 66, p 1226-1232, 2004

The authors discuss the utility and use of decision support tools for identifying available options for the remediation of polychlorinated pollutants. These tools may be particularly useful for weighing and measuring options where the interplay of other competitive criteria hampers the process of decision making.

<http://www.ics.trieste.it/Documents/Downloads/df2269.pdf>

Defining and Characterizing the Biologically Active Zone in Sediments: a Review of Approaches and Current Data

Iannuzzi, T. (BBL Sciences, Annapolis, MD), P. Krause, D. Edge, J. Holder, K. Jenkins, D. Ludwig, C. Barnes, J. Hall, and S. Truchon.

SETAC 26th Annual Meeting in North America, 13-17 November 2005, Baltimore, Maryland.

Most ecological risk assessments for contaminated sediments focus on a surface layer of sediment where bioturbation and mixing occur, and the exposure potential is highest for invertebrates and fish. This layer is often referred to as the biologically active zone, or BAZ. Although defining the BAZ is a critical path in the risk-based sampling process, few studies have been published and no national regulatory guidance has been issued that focus on developing a common process for its quantification and characterization. The authors have reviewed case studies from the literature and regulatory reports and synthesized data and information regarding the strategic approaches and sampling methods that have been applied to defining the BAZ. An overall interpretation of the findings from these studies is provided, accompanied by the pros and

cons of various sampling parameters that have been used to measure and characterize the BAZ. The authors are investigating how consistent the definition of the BAZ and its characteristics are on a seasonal and regional basis.

Design of Asymmetric DNAzymes for Dynamic Control of Nanoparticle Aggregation States in Response to Chemical Stimuli

Liu, J. and Yi Lu, Univ. of Illinois at Urbana-Champaign.

Organic and Biomolecular Chemistry, Vol 4, p 3435-3441, 2006

In previous work, a Pb²⁺-specific DNAzyme allowed dynamic control of gold nanoparticle aggregation states in response to Pb²⁺, exhibiting a color change response from blue aggregates to red dispersed particles. A small piece of invasive DNA and low ionic strength (~30 mM) were required for the process, which limited the scope of application in assembly and sensing. To overcome this limitation, a series of symmetric DNAzymes, in which one of the two substrate binding regions is longer than the other, has been developed and demonstrated for Pb²⁺-induced disassembly of gold nanoparticle aggregates and corresponding color change at room temperature, without the need for invasive DNA. The system also accepts a greater range of ionic strength, from 33 to 100 mM.

<http://montypython.scs.uiuc.edu/paper.htm>

Detection of Landmines and Suspected Minefields Using Novel Amplifying Fluorescent Polymers

La Grone, M., M. Fisher, C. Cumming, and E. Towers, Nomadics, Inc., Stillwater, OK.

Report No: NATICK/TR-03/010, NTIS: ADA409370, 23 pp, Dec 2002

This report describes continuing efforts to detect landmines by using novel fluorescent polymers that sense the ultra-trace concentrations of nitroaromatic compounds emanating from explosives contained in mines. Scientific studies were made under contract and several new generations of detectors were developed and tested in an effort to understand the chemical signature of landmines. It has been shown that the landmine chemical signature tends to be heterogeneous and can be dispersed in the environment near the mine location, which makes it difficult to pinpoint the exact location of the mine using trace chemical detection methods; however, evidence currently available indicates that it may be possible to isolate a mine location to within a small, well-defined area. Also discussed in this report is a promising method for standoff detection of suspected mines using small beads coated with the amplifying fluorescent polymer. Nomadics was able to demonstrate the detection of the quenching effect at a distance of 58 meters.

<http://handle.dtic.mil/100.2/ADA409370>

Determination of Biodegradation Potential by Two Culture-Independent Methods in PAH-Contaminated Soils

Moon, H.S.; H.-Y. Kahng; J.Y. Kim; J.J. Kukor; K. Nam, Seoul National Univ., Seoul, South Korea.

Environmental Pollution, Vol 140 No 3, p 536-545, 2006

To examine the biodegradation potentials of polycyclic aromatic hydrocarbons (PAHs) in PAH-contaminated and uncontaminated field soil samples, putative dioxygenase genes were

amplified by a primer set specific for initial dioxygenases and identified by a Web-based database homology search. Four dioxygenases were selected as probes for DNA hybridization. The hybridization signals according to the presence of putative dioxygenases were positively related to the extent of PAH contamination, but signal intensity varied depending on the probes' hybridization and were not consistent with PAH biodegradation activities determined by carbon dioxide evolution. The data clearly show that the variations of assessment results depend upon the genetic information used, which suggests that the methodology may tend to underestimate the real biodegradation capacity of a site, likely due to the limited dioxygenase database available at the moment. These results indicate that the molecular assessment of biodegradation potential should involve a very careful primer and probe design and an extensive microbiological examination of the site to accurately delineate its biodegradation potential.

Determination of NO and NO₂ Aircraft Emission Indices at Airports by Open-Path DOAS
Schafer, K., G. Schurmann, S. Emeis, C. Jahn, and H. Hoffmann, Forschungszentrum Karlsruhe, Garmisch-Partenkirchen, Germany.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

Though emission indices for NO_x and CO are listed for each aircraft engine in a database of the International Civil Aviation Organisation for different thrust levels (idle, approach, cruise and takeoff), actual emissions of aircraft at an airport are not well known. A method to determine emission indices of aircrafts under different operational scenarios is introduced that measures concentrations of CO₂ with other pollutants (NO, NO₂, CO) within the aircraft exhaust plumes. Differential optical absorption spectroscopy (DOAS) were used for NO and NO₂ as well as Fourier transform infrared (FTIR) spectrometry for CO₂ and CO in an emissions measurement project that did not interfere with airport operations due to its stand-off nature. Knowing the emission index of CO₂ from total combustion of kerosene allows the emission indices of the other compounds to be determined with the concentration measurements. Detailed observations of taxiway movements in relation to emissions are also important. The field studies were conducted on two airports and were focused on the emission rate estimation of CO and NO_x. The results are presented and compared with International Civil Aviation Organisation emission indices.

Developing Strategies for Use in the Per technetate Spectroelectrochemical Sensors: Studies of PVTAC-PVA and Metal(vbpy)₃+2 FILMS

Paddock, Jean, Ph.D. dissertation, University of Cincinnati, 188 pp, 2004

The Chemical Sensors research group at the University of Cincinnati has been working on the problem of developing a spectroelectrochemical sensor for radioactive technetium-99 (Tc-99) in the form of per technetate (TcO₄⁻). DOE in particular would like to see a remote, portable sensor able to detect Tc-99 levels in situ or with point-of-interest continuous monitoring. Currently, such a sensor does not exist. This work presents several steps continuing the research toward a per technetate chemical sensor. The sensor concept combines spectroscopy and electrochemistry to achieve selectivity (detecting per technetate only) and sensitivity (detecting low levels of occurrence) in one device. One of its major components is a chemically selective film which serves both as an initial level of per technetate charge- or ligand-based interaction and as its preconcentration device. This dissertation presents further study on two

films meant for use in the spectroelectrochemical sensor: poly(vinylbenzyltrimethylammonium chloride) blended with a poly(vinylalcohol) host (PVTAC-PVA) and a ligand-based film combining a metal with 4-vinyl-4'-methyl-2,2'-bipyridine (Metal(vbpy)₃+2). The PVTAC/PVA film has been previously developed and more specific studies of details affecting its performance in the sensor are discussed. The metal/ligand film is part of a promising direction involving ligand incorporation into a chemically selective film, thereby increasing pertechnetate specificity and improving its spectroscopic and electrochemical properties. Also included are studies of new film substrates.

http://www.ohiolink.edu/etd/view.cgi?acc_num=ucin1092854913

Development of a Set of Simple Bacterial Biosensors for Quantitative and Rapid Measurements of Arsenite and Arsenate in Potable Water

Stocker, J., D. Balluch, M. Gsell, H. Harms, J. Feliciano, S. Daunert, K.A. Malik, and J.R. van der Meer.

Environmental Science & Technology, Vol 37 No 20, p 4743-4750, 15 Oct 2003

The authors describe the development of a set of bacterial biosensors based on a nonpathogenic laboratory strain of Escherichia coli, the natural resistance mechanism of E. coli against arsenite and arsenate, and three reporter proteins: bacterial luciferase, beta-galactosidase, and green fluorescent protein (GFP). The biosensors were genetically optimized to reduce background expression in the absence of arsenic. In calibration experiments with the biosensors and arsenite-amended potable water, arsenite concentrations at 4 ug of As/L (0.05 uM) were routinely and accurately measured. Field testing for arsenite was achieved with a system that contained beta-galactosidase, producing a visible blue color at arsenite concentrations above 8 ug/L. A sensor protocol was developed in which the sensor cells were dried on a paper strip and placed in the aqueous test solution for 30 min, after which time color development was allowed to take place. The GFP sensor showed good potential for continuous rather than end point measurements.

<http://instructional1.calstatela.edu/ckhachi/REU/Projects/Arsenic/Biosensor/EST%202003%20paper.pdf>

Development of a Surface-Enhanced Raman Spectroscopy (SERS)-Based Sensor for the Long Term Monitoring of Toxic Anions

Strategic Environmental Research and Development Program (SERDP). 168 pp, June 2003

The objective of this project is to demonstrate the detection of perchlorate, chromate, dichromate, and cyanide anions using cationic-coated SERS substrate. The thiol coating attracts the anions to the SERS substrate, where they are identified and quantified by their characteristic Raman emission. The cationic coating stabilizes the SERS substrate, thereby extending its lifetime, and it has a characteristic SERS spectrum, which can be used as an internal calibration standard. The advantages of this approach over conventional techniques are (1) the required information is obtained in real time, (2) it doesn't require the additional cost of an outside laboratory, and (3) decisions can be made in a timely fashion as to whether or not additional sampling is required and where that sampling is needed. Methods of improving selectivity and sensitivity are addressed, as well as sensor design.

<http://docs.serdp-estcp.org/viewfile.cfm?Doc=CU%2D1296%2DFR%2Epdf>

Development of an Extraction Method for Perchlorate in Soils

Canas, J.E., R. Patel, K. Tian, and T.A. Anderson.

Journal of Environmental Monitoring, Vol 8, 399-405, 2006

The current U.S. EPA methods for perchlorate determination via ion chromatography using conductivity detection do not include recommendations for the extraction of perchlorate from soil. Researchers evaluated and identified appropriate conditions for the extraction of perchlorate from clay loam, loamy sand, and sandy soils and concluded that soils should be extracted in a dry, ground (mortar and pestle) state with Milli-Q water in a 1:1 soil:water ratio and diluted no more than 5-fold before analysis. When sandy soils were extracted in this manner, the calculated method detection limit was 3.5 ug/kg.

DIAL Measurement of Fugitive Emissions from Natural Gas Plants and the Comparison with Emission Factor Estimates

Chambers, A. and M. Strosher (Alberta Research Council, Inc., Canada); T. Wootton, J. Moncrieff, and P. McCready (Spectrasyne Ltd., UK).

15th Annual Emission Inventory Conference: Reinventing Inventories--New Ideas in New Orleans, 16-18 May 2006, New Orleans, Louisiana.

Natural gas processing is a major industry and a significant source of fugitive emissions of both methane and volatile organic hydrocarbons (VOCs). Fugitive emissions at natural gas processing plants in Alberta, Canada, were investigated using two complementary optical measurement methods. At five gas plants, the fugitive emissions of methane and volatile organic hydrocarbons were measured and quantified using differential absorption lidar (DIAL). At two of the plants, a gas leak imaging camera was also used to locate individual hydrocarbon leaks. DIAL is a remote optical method that can measure hydrocarbon concentrations in the atmosphere at distances up to several hundred meters from the instrument. When combined with wind speed and direction, the DIAL concentrations measurements can be used to determine total emissions of hydrocarbons from an industrial site as well as proportioning the emissions to various parts of the plant. For the five gas plants surveyed in Alberta with the DIAL method, the measured methane fugitive losses ranged from 100 to 146 kg/hr, and VOC losses ranged from 38 to 342 kg/hr. At one of the gas plants, over \$1 million of hydrocarbon product was lost per year due to equipment leaks. Compressors and condensate storage tanks were two significant emission sources at all of the gas plants. Process flares operating on pilot were typically responsible for 10 to 15% of the total methane emissions. The DIAL measured emissions of methane, VOCs, and benzene were compared with the values calculated with emission factor methods. Measured emissions of methane and VOCs were four to eight times higher than the emission factor estimates. The largest differences between measured values and estimates were for the flares and storage tanks. DIAL was an effective method to quantify fugitive losses of hydrocarbons from the gas processing plants. The DIAL measured values gave a more realistic evaluation of revenue lost as fugitives than the industry-accepted estimation methods, leading to an increased incentive to improve leak detection and repair.

<http://www.epa.gov/ttn/chief/conference/ei15/session14/chambers.pdf>

The Dipole Flow and Reactive Tracer Test as a Novel Aquifer Assessment Tool

Berryman, C.J., D. McKnight, N. Nayagum, M. Mohamed, A.L. Smalley, S.A. Banwart, S.F. Thornton, and R.D. Wilson (Univ. of Sheffield, UK); N.R. Thompson (Univ. of Waterloo, Canada); D.N. Lerner (Univ. of Sheffield).

Aquifer Contamination and Insitu Remediation, 23 March 2006, British Geological Survey, Keyworth, Nottingham, UK. The Hydrogeological Group of the Geological Society.

The dipole-flow reactive-tracer test (DFRTT) offers a potentially cost-effective method for reliable site investigation to quantify site-specific parameter values for reactive transport modeling that is used for performance assessment of the natural attenuation of contaminants in groundwater. The dipole flow tracer test (DFTT) is described as a single-borehole technique utilizing inflatable packers to create two isolated chambers within the borehole. By use of a pump, a forced-gradient dipole flow field is created to circulate groundwater through the surrounding aquifer. The dipole flow test (DFT) has been applied in a fractured sandstone aquifer during field trials at the Site for Innovative Research on Natural Attenuation (SIReN) in the UK. Initial results confirm the ability of the DFT to characterize the hydraulic properties of the aquifer and demonstrate successful tracer injection and recovery in the sandstone formation.

Direct Determination of Cyanides by Potentiometric Biosensors

Keusgen, M. Univ. of Marburg, Marburg, Germany (Univ. of Marburg, Marburg, Germany); J.P. Kloock; D.-T. Knobbe; M. Junger; I. Krest; M. Goldbach; W. Klein; M.J. Schoning.

Sensors and Actuators B: Chemical, Vol 108 Nos 1-2, p 925-932, 22 July 2005

A cyanide-specific biosensor exploiting immobilized cyanidase (EC 3.5.5.1) has been developed. Enzymatically formed ammonia is detected either by a potentiometric sensor based on an ammonia electrode or by a pH-sensitive electrolyte/insulator/semiconductor (EIS) layer structure made of Al/p-Si/SiO₂/Si₃N₄. Sensitivity of either biosensor is sufficient to detect cyanide in sub-toxic concentrations, with a detection limit in the micromolar concentration range.

Direct Push Tool: Use of Direct Push Wells for Long-Term Groundwater Monitoring

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 20 pp, Aug 2005

The use of direct-push technology could significantly reduce the installation and sampling costs associated with long-term monitoring wells. Naval Facilities Engineering Command (NAVFAC) has conducted demonstration studies at several sites across the country to validate the use of direct push wells for long-term monitoring purposes and to promote regulatory acceptance of this approach. This Web tool provides Navy Remedial Project Managers with information about the use of direct push technology for monitoring well installation and provides case study information and performance data from NAVFAC's comparative groundwater monitoring studies.

<http://www.ert2.org/ert2portal/DesktopDefault.aspx>

Distribution Characteristics of Ammonia-Oxidizing Bacteria in the *Typha latifolia* Constructed Wetlands Using Fluorescent In Situ Hybridization (FISH)

Yan, L., R. Inamori, P. Gui, K.-Q. Xu, H.-N. Kong, M. Matsumura, and Y. Inamori, Shanghai Jiao Tong Univ., Shanghai, China.

Journal of Environmental Sciences, Vol 17 No 6, p 993-997, 2005

In constructed wetlands containing cattail (*Typha latifolia*), fluorescent in situ hybridization (FISH) was used to investigate the vertical distribution characteristics of ammonia-oxidizing bacteria (AOB), their quantity, and the relation with oxidation-reduction potential (ORP) under three different loadings in the summer. AOB quantity was found to decrease with the increase of vertical depth; however, AOB quantity was 2 to 4 times greater in the root area than in that of the control. ORP in the rhizosphere was higher than other areas, which showed that *Typha latifolia* CW was in an aerobic state in summer when receiving simulated non-point sewage.

Divalent Cation Assisted Downselection of DNAzymes for Detection of Nitroaromatic Molecules

Cropek, D.M., S. Kobylewski, T. Lam, J.H. Lee, Y. Lu, and A. Brown.

Pittcon 2006, March 12-17, Orlando, FL.

SELEX is an iterative process used to identify an aptamer to a chosen molecular target. The method relies on standard molecular biological techniques and can be carried out manually or in an automated fashion. The process can be broken down conceptually into four steps: (1) pool preparation, (2) selection, (3) amplification, and (4) aptamer isolation. This paper describes an investigation of the self-catalytic capabilities of single-stranded DNA/RNA hybrid sequences for their potential use as real-time, analyte-specific biosensors of military-unique compounds. DNA is engineered to contain segments of known sequences, a random sequence, an intentionally placed ribonucleotide containing a labile 3' hydroxyl group, and a fluorescent tag. Contaminant interaction with the random segment causes self-cleavage at the RNA site, thus releasing the fluorophore. Optical detection of the fluorophore provides qualitative and quantitative information on the contaminant. The authors report on the adaptation of the SELEX method in the presence of military-unique compounds. Modifications will allow for selection of DNAzymes that cleave in the presence of nitroaromatic analytes such as TNT, aniline, 2,4-DNT, nitrosobenzene, and nitrobenzene.

DNAPL Detection and Characterization Tool

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 24 pp, Mar 2005

The cleanup of sites contaminated with dense nonaqueous-phase liquid (DNAPL) is a major challenge. Approximately 867 chlorinated solvent sites have been identified at Navy and Marine Corps installations. An estimated 5 to 10% of these sites have chlorinated solvent contamination present as DNAPL. DNAPL sources are difficult to locate and characterize. In many cases, only limited information exists about the potential source and the location of the release. Also, DNAPLs have complex migration patterns, and small amounts of residual DNAPL can produce large dissolved-phase plumes. These factors make DNAPL detection and removal from the subsurface challenging and costly. The goal of DNAPL detection and characterization

is to develop a conceptual site model that focuses on stratigraphy, including migration pathways and traps. Source investigation methods that provide desired remediation data and simultaneously minimize the risk of contaminant mobilization should be selected. DNAPL detection and characterization strategies will vary depending on the remediation goal (i.e., containment vs. removal). This tutorial describes the invasive and non-invasive tools that are available to perform DNAPL investigations; however, each site is unique, and there is no practical cookbook approach for characterization.

<http://www.ert2.org/ert2portal/>

DNAzyme-Directed Assembly of Gold Nanoparticles as Colorimetric Sensors for a Broad Range of Analytes

Liu, Juewen and Yi Lu, Univ. of Illinois at Urbana-Champaign.

IEEE NANO 2003 Conference Proceedings, 12-14 August 2003, San Francisco, California.

DNAzymes have been used for directed assembly of gold nanoparticles in which the assembly state is highly dependent on the presence of specific analytes such as Pb²⁺ or adenosine. The resulting system provides a highly sensitive and selective colorimetric biosensor for metal ions and organic molecules. The methodology is generally applicable to almost any chosen analyte(s).

<http://ieeenano2003.arc.nasa.gov/THM2.pdf#search=%22dnazyme%22>

DoD Perchlorate Handbook

Department of Defense Environmental Data Quality Workgroup. 81 pp, Mar 2006

This handbook was produced by DoD's Environmental Data Quality Workgroup to assist DoD facilities in complying with current DoD policy governing perchlorate sampling and testing activities for both environmental restoration/cleanup and compliance monitoring programs. Intended users of this document include DoD Remedial Project Managers, contractor project managers, and field-sampling personnel. The handbook provides guidance in the following areas: (1) using conceptual site models to develop project quality objectives associated with sampling and analysis for perchlorate, (2) designing sampling strategies and implementing appropriate sampling techniques, (3) selecting qualified analytical laboratories and analytical methods based on required performance objectives, and (4) documenting the above in project planning documents.

<http://www.navylabs.navy.mil/Archive/DODPerchlorateHandbook.pdf>

or

<http://www.dodperchlorateinfo.net/efforts/policy/documents/Perchlorate%20Handbook%20Final%203-30-06.pdf>

Downward Solute Plume Migration: Assessment, Significance and Implications for Characterization and Monitoring of "Diving Plumes"

American Petroleum Institute (API) Soil and Groundwater Technical Task Force.

API Bulletin 24, 38 pp, Apr 2006

This document was produced to promote a common understanding of the phenomenon of diving plumes. The term "diving plume" refers to the gradual downward vertical migration of a

dissolved-phase contaminant plume to greater depths in the subsurface with increasing distance along the flow path, resulting in the existence of a region of uncontaminated water overlying portions of the plume. An unrecognized diving plume could result in an inadequate evaluation of risk to receptors, erroneous interpretation of the significance of natural attenuation, under-design of a remediation system, or inadequate assessment of remedial performance.

<http://www.epa.gov/ehs/groundwater/upload/bull24-2.pdf>

Draft Technical Protocol for Characterizing Natural Attenuation of Chlorinated Solvent Ground-Water Plumes Discharging into Wetlands--An Addendum to the Air Force Center for Environmental Excellence (AFCEE) Chlorinated Solvent Natural Attenuation Protocol. Natural Attenuation of Chlorinated Solvent Ground-Water Plumes Discharging into Wetlands. U.S. Geological Survey Scientific Investigations Report 2004-5220, Section 4, p 4.1-4.41, 2005

The technical methodologies included in this protocol for monitoring the natural attenuation of wetland discharges include collection of soil/sediment borings, reconnaissance methods and strategies, installation of multi-level piezometer (or groundwater sampler) transects, and characterization of the hydrogeology and biogeochemistry.

<http://pubs.usgs.gov/sir/2004/5220/pdf/sir-2004-5220.pdf>

Dual-Response Resonant Chemical Sensors for Multianalyte Analysis

Potyralo, R.A. and T.M. Sivavec, General Electric Company, Global Research Center, Schenectady, NY.

Sensors and Actuators, B: Chemical, Vol 106 No 1, p 249-252, 29 Apr 2005

Resonant, thickness-shear mode (TSM) sensors are intended for integration into a microanalytical system that will periodically collect and precondition a predetermined volume of sample and present it to the sensor for analysis. Each side of the TSM resonator is coated with a different sensor film. During measurements, only one side at a time is exposed to an analyzed vapor while another side is exposed to a blank gas from a scrubber. The analyte-related signals are generated independently from each side of the TSM sensor. This dual-response sensing approach reduces the number of sensing elements by a factor of two, allowing system miniaturization and improved power budget in sensor operation. The researchers demonstrated the dual-response sensor concept with a single, high-performance, low-noise TSM resonator, successfully discriminating and quantifying vapors such as toluene, trichloroethene, and two isomers of dichloroethene.

Effect of Groundwater Composition on Arsenic Detection by Bacterial Biosensors

Harms, H. (UFZ Centre for Environmental Research Leipzig-Halle, Germany); J. Rime (Swiss Federal Inst. of Technology Lausanne); O. Leupin and S.J. Hug (Swiss Federal Inst. for Environmental Science and Technology); J.R. van der Meer (Univ. of Lausanne).

Microchimica Acta, Vol 151, p 217-222, 2005

A luminescent bacterial biosensor was used to quantify bioavailable arsenic in artificial groundwater. Its light production above the background emission was proportional to the arsenite concentration in the toxicologically relevant range of 0 to 0.5 μM . Effects of the inorganic solutes--phosphate, Fe(II), and silicate--on the biosensor signal were studied. Phosphate at a

concentration of 0.25 g/L phosphate slightly stimulated the light emission, but much less than toxicologically relevant concentrations of the much stronger inducer arsenite. No effect of phosphate was observed in the presence of arsenite. In the presence of 0.4 mg/L Fe(II), the arsenite-induced light emission was reduced by up to 90%. Addition of 100 mM EDTA was capable of releasing all arsenic from the precipitate and to transform it into the biologically measurable dissolved state. The biosensor also proved valuable for monitoring the effectiveness of an arsenic removal procedure based on water filtration through a mixture of sand and iron granules.

<http://instructional1.calstatela.edu/ckhachi/REU/Projects/Arsenic/Biosensor/paper%201.pdf>

Effect of Precipitation on Low Frequency Electrical Properties of Zerovalent Iron Columns
Wu, Yuxin and Lee D. Slater (Rutgers Univ., Newark, NJ); Nick Korte (Grand Junction, CO).
Environmental Science & Technology, Vol 39 No 23, p 9197-9204, 2005

The application of a noninvasive electrical method to monitor precipitation in columns containing elemental iron (zero-valent iron, or Fe(0)) was investigated using sodium sulfate (Na₂SO₄) and sodium carbonate (Na₂CO₃) solutions. Because variations in electrolytic conductivity and porosity were minimal, electrical changes are attributed to higher complex interfacial conductivity due to increased surface area and mineralogical alteration and to increased electronic conduction due to enhanced electron transfer across the iron/fluid interface. The results show that electrical measurements are a proxy indicator of elemental iron surface alteration. Though greater changes would be expected to occur in the electrical parameters measured over long-term monitoring of an iron-filled permeable reactive barrier (PRB) than are described in this study, the technique may provide a noninvasive way to monitor long-term performance of a PRB installation.

<http://www.andromeda.rutgers.edu/~geology/Faculty/Slater/Wu%20ES&T.pdf>

Electrical Conductivity of Lime Neutralization Sludge: Implications for Monitoring Remediation Efforts at Fire Road Mine

Yeomans, T. and K.E. Butler (Univ. of New Brunswick, Fredericton, NB); M. Coleman (NB Coal Limited, Minto, NB). Halifax 2005: GAC-MAC-CSPG-CSSS Joint Meeting, Halifax, Nova Scotia: Abstracts, Vol 30, p 214, 2005

At the Fire Road strip mine in central New Brunswick, concern over the growing area required for sludge storage prompted NB Coal Limited to begin disposing of sludge onto the acid-generating waste rock that had been used to backfill the abandoned cut. It was anticipated that sludge might also plug void space within the waste rock, thus reducing the downward diffusion of oxygen and production of acid mine drainage (AMD). The relocation of sludge to the waste rock may be partially responsible for the general improvements in mine water quality over the past 13 years, though there was no way, apart from trenching, to determine where sludge migrates and ultimately resides after it infiltrates below the porous waste rock surface. In 2004, an EM31 terrain conductivity survey of the mine site revealed that it was possible to locate sludge in the subsurface and trace its lateral migration by mapping spatial variations in apparent conductivity. The elevated apparent conductivities observed over former areas of sludge deposition may be caused by the presence of moist conductive sludge in the void space above the water table. Sludge may also be filling void space below the water table and thereby displacing

conductive AMD waters. The authors present laboratory column experiments carried out to determine the electrical conductivity of lime neutralization sludge, its dependence on moisture content, and how it compares to the conductivity of groundwaters within the backfilled mine. The results of these experiments will help to determine whether such surveys can be used in a quantitative way to assess the effectiveness of sludge applications as a remediation tool.

Electrochemical Analysis at the Microbe/Mineral Interface

Turick, C.E. and A.A. Ekechukwu (Savannah River National Laboratory, Aiken, SC); D.A. Lowy (Nova Research, Inc., Alexandria, VA).

The 15th Annual Goldschmidt Conference, 2005: Abstracts, A370, 2005

Dissimilatory metal-reducing bacteria (DMRB) grow by transferring electrons directly to solid, insoluble metal oxides, thereby contributing to the biogeochemical cycling of metals. By examining how DMRB transfer electrons from the cell to solid minerals, this phenomenon can be better predicted and controlled as it relates to the biogeochemical cycling of metals, including the bioremediation of metal-contaminated environments. Novel analytical methods have been developed that address electron transfer (ET) from whole cells and their reactivity with specific solid terminal electron acceptors, including metal oxides, through the use of cyclic voltammetry (CV). *Shewanella oneidensis* MR-1, a model DMRB, is capable of coupling H₂ oxidation to the reduction of solid terminal electron acceptors. Living cells of *S. oneidensis* MR-1 demonstrate ET to several types of working electrodes (including Fe(III) oxide/carbon paste electrodes), under anaerobic conditions in the presence of H₂. Differences in ET were recorded using bacterial mutants with altered metal reduction capabilities as well as with different electrode surface composition.

Electromagnetic Surveys Web Data Sheet

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 25 pp, Mar 2005

The use of electromagnetic (EM) surveys has been proposed for the delineation of nonaqueous phase liquids (NAPLs) in the subsurface; however, an EM survey should not be considered a stand-alone site characterization tool because its usefulness for the detection and delineation of NAPLs is limited. The lessons learned presented in this Web Data Sheet describe these warnings and site-specific challenges in more detail. Case study results from NAVFAC sites are also discussed where EM surveys have been used both successfully and unsuccessfully to identify the extent of NAPL impacts.

<http://www.ert2.org/ert2portal/DesktopDefault.aspx>

Electrospun Polymer Composite Fiber Arrays for the Detection and Identification of Volatile Organic Compounds

Kessick, Royal and Gary Tepper, Sentor Technologies Inc., Glen Allen, VA.

Sensors and Actuators, B: Chemical, Vol 117 No 1, p 205-210, 12 Sep 2006

Electrospun polymer composite fibers were deposited in the form of aligned arrays onto interdigitated microelectrodes. The fibers consist of an insulating polymer blended with carbon black near the percolation threshold, hence the fiber resistance increases when the polymer

component swells during vapor absorption. Microsensors were fabricated from four different cross-selective polymers, and the electrical resistance of each element of the four-component sensor array was tested upon exposure to toluene, trichloroethene, methanol, and dichloropentane vapors. The unique response pattern from the sensor array for each of the 4 organic compounds allowed their discrimination.

Elemental Mercury Emissions from Chlor-Alkali Plants Measured by Lidar Techniques
Gronlund, R., M. Sjöholm, P. Weibring, H. Edner, and S. Svanberg.
Atmospheric Environment, Vol 39 No 39, p 7474-7480, Dec 2005

Differential absorption lidar (DIAL) techniques have been utilized to measure elemental gaseous mercury fluxes from mercury cell chlor-alkali plants as a part of a project funded by the European Union. Three plants were selected for the study, and a total of six measurement campaigns have been performed--one intercalibration campaign and five flux evaluation campaigns--in both winter and summer. The measurements were carried out using the Swedish optical parametric oscillator (OPO)-based mobile lidar system developed at Lund Institute of Technology. Results show large differences in the seasonal mercury emissions measured at the different plants.

Electrochemical Magnetoimmunosensing Strategy for the Detection of Pesticides Residues
Zacco, E., M.I. Pividori, S. Alegret, R. Galve, and M.-P. Marco.
Analytical Chemistry, Vol 78 No 6, p 1780-1788, 2006

A strategy for the detection of atrazine is based on magnetic beads. The immunological reaction for the detection of atrazine performed on the magnetic bead is based on a direct competitive assay using a peroxidase (HRP) tracer as the enzymatic label. After the immunochemical reactions, the modified magnetic beads are captured by a magnetosensor made of graphite/epoxy composite, which is also used as the transducer for the electrochemical immunosensing. Electrochemical detection is achieved through a suitable substrate and mediator for the enzyme HRP. The detection limit for atrazine using the competitive electrochemical magnetoimmunosensing strategy with anti-atrazine-specific antibody covalent coupled with tosyl-activated magnetic beads was found to be 0.027 nmol/L.

Environmental Technology Verification Report: Constellation Technology Corporation, CT-1128 Portable Gas Chromatograph-Mass Spectrometer
Mangaraj, R., A. Dindal, Z. Willenberg, and K. Riggs, Battelle.
U.S. EPA, ORD, Environmental Technology Verification Program, 56 pp, May 2006

The CT-1128 analyzes known and unknown chemicals on site. The CT-1128 is a lightweight, ruggedized, field-deployable GC-MS system that can accommodate the applications of traditional lab-based GCMS systems. With the appropriate extraction techniques, analysis can be performed on a variety of matrices including DW, which can be prepared using SPME. The CT-1128 weighs approximately 75 pounds and is 15 in x 23 in x 15 in. It is contained in a carrying case housing the entire system. The system has a range of 1.6 to 800 atomic mass units with unit resolution throughout the mass range. In selected ion mode, it can scan for 50 groups of masses with 30 masses per group. For identification of chemicals, the CT-1128 is equipped with

an automated mass spectral data base searching function that can use a range of commercial mass spectral libraries (e.g., NIST Mass Spectral Library) as well as user-defined libraries. The system is controlled with a laptop computer that uses a program for GC control and MSD Chemstation (Agilent Technologies) for MS control and data analysis. The CT-1128 requires ultra-high purity hydrogen or helium (or nitrogen if desired) for the carrier gas, using either an external gas tank or its on-board hydrogen storage bottle. The metal hydride storage bottle can be charged with hydrogen to provide a source of carrier gas that is convenient for mobile operation. The mass spectrometer can be tuned using an internal calibrant, such as perfluorotributylamine, to perform a standard spectra tune or autotune (for maximum sensitivity over the entire scanning range) depending on the user's needs. At the time of testing, the cost of the CT-1128 GC-MS system, with optional SPME stirrer/heater, was \$140,000. Because the CT-1128 requires time for thermal equilibration once electrical power and gas have been supplied, it should be kept on standby (under vacuum and thermally equilibrated) as long as possible when time is a critical factor for analyzing field samples. Mobilization in the field is straightforward, and the system requires only a source of electrical power for several hours of field deployment when used with its on-board hydrogen canister for a source of carrier gas. Typical extraction and sample run times ranged from 22 minutes to 32 minutes. Average sample throughput during verification testing was 11 samples per 10-hour working day, or approximately one sample per hour. For 100 samples, the total cost for supplies was approximately \$914, not including the GC column and standard chemicals.

<http://www.epa.gov/etv/verifications/vcenter1-36.html>

Environmental Technology Verification Report: Abraxis, AbraTox Kit
Schrock, M., R. James, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.
U.S. EPA, ORD, Environmental Technology Verification Program, 48 pp, June 2006

The AbraTox Kit is an in vitro testing system that uses a naturally occurring and non-pathogenic bioluminescent bacteria *Vibrio fischeri* (strain NRRL-B-11177) to determine the toxicity of water-soluble samples. *Vibrio fischeri*, when properly grown, emits light as part of its metabolic pathway; the emitted light is an indication of the metabolic status of the bacterium. Differences in the amount of light produced can therefore be correlated to bacterial metabolism. Toxic compounds interfere with the metabolic process, resulting in a reduction of light emission. The reduction of light emitted is proportional to the toxicity of the sample--the more toxic the sample, the greater percentage of light reduction. The AbraTox *Vibrio fischeri* reagent vials are supplied freeze dried. To analyze the water samples, the vials are reconstituted with 2.5 milliliter (mL) of cold reconstitution solution and allowed to hydrate under refrigerated conditions for 30 minutes. Meanwhile, 800 microliters (uL) of the water sample to be analyzed are added to test cuvettes, followed by the addition of 100 uL of osmotic adjusting buffer, and allowed to incubate in the refrigerated incubation chamber for at least 15 minutes. Then, 100 uL of the diluted bacteria are added to a negative control and to each test sample and incubated in the refrigerated incubation chamber for 15 to 60 minutes. Luminescence is measured using a portable luminometer. Significant changes in luminescence compared to the negative control (or reference sample) reflect the toxicity of the test sample. The AbraTox Kit contains six vials of freeze-dried bacteria, two vials of reconstitution solution, one bottle of osmotic adjusting buffer, and one vial of positive and negative control. Test cuvettes, a repeater pipette (100 uL), and a 200 to 1,000 uL pipette and tips are required but not provided. The box containing the AbraTox Kit is 18 x 13 x 8

cm in dimension. The AbraTox luminometer is 20 x 8 x 5 cm, uses 2 AA batteries, and weighs 0.3 kilograms. It can be integrated (though it was not during this test) with a personal computer for data acquisition, evaluation, and storage. The price of the AbraTox Kit (150 single tests) is \$250, the luminometer is \$2,000, and the incubation chamber is \$250.

<http://www.epa.gov/etv/verifications/vcenter1-27.html>

Environmental Technology Verification Report: Aqua Survey, Inc. Chem-IQ Tox(tm) Test Kit
Schrock, M., R. James, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 49 pp, June 2006

The Chem-IQ Tox(tm) Test Kit detects toxicants in drinking water using a chemical reaction that generates fluorescence. The test can be conducted by a technician with basic laboratory skills. Sample analysis is performed by adding two reagents to test and control water samples and measuring each sample's fluorescence with a calibrated fluorometer. Percent inhibition values are calculated by comparing the light production of the control with that of the test samples. If the average percent inhibition value of the replicate test samples is greater than 20%, the test water sample is considered significantly impacted by a toxicant: a positive response. The Chem-IQ Tox(tm) Test Kit, which costs \$250, contains 30 vials each of two reagents, 90 IQ Exposure Chambers, disposal reagent pipettes, Chem-IQ Tox(tm) Test Kit score cards, and a Sharpie pen. Materials and laboratory equipment required for the test include an Aquafluor(tm) hand-held fluorometer (Turner Design) or equivalent and a supply of non-fluorescing 4 milliliter cuvettes (10 mm x 10 mm); an automatic pipetter or equivalent with appropriate disposable tips for dispensing 10-mL, 250-uL, and 50uL volumes; a PC3 liquid sonicator (L&R) or equivalent; a magnetic stir plate and stir bar (1/8-inch diameter); a distilled or deionized water supply; and a digital timer that displays seconds.

<http://www.epa.gov/etv/verifications/vcenter1-27.html>

Environmental Technology Verification Report: CheckLight Ltd., ToxScreen-II Test Kit
Schrock, M., R. James, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 61 pp, June 2006

ToxScreen-II provides on-site detection of organic and inorganic toxicants, such as heavy metals, pesticides, herbicides, chlorinated hydrocarbons, polychlorinated biphenyls, BTEX compounds, and phencyclidine. ToxScreen-II can be used in both field and laboratory testing. Typical applications include effluent toxicity testing, surface and ground water screening for changes in water quality, and raw drinking water monitoring for early warning of dangerous spills, accidents, and sabotage/bioterrorism. Under proper conditions, luminous bacteria emit high and steady levels of luminescence. Chemical and biological toxicants that affect cell respiration, electron transport systems, adenosine triphosphate generation, and the rate of protein or lipid synthesis alter the level of luminescence. Similarly, agents that affect cell integrity and membrane function have a strong effect on luminescence. Hence, toxicants of different characteristics such as pesticides, herbicides, chlorinated hydrocarbons, and heavy metals exert a measurable effect on a bacterial luminescence system. By comparing the luminescence level obtained in a suspected toxic sample with that obtained in a clean water control sample after a short period of incubation, very low concentrations of a broad range of toxicants can be detected. To detect toxicants in water samples, ToxScreen-II uses a highly sensitive variant of

Photobacterium leiognathi and two assay buffers: one for detecting heavy metals (Pro-Metal Buffer) and the other for organic pollutants (Pro-Organic Buffer). When used concurrently, these buffers are designed to discriminate between the presence of organic and metal toxicants at submilligram per liter concentrations. The ToxScreen-II luminometer is 150 millimeters (mm) wide by 280 mm deep by 170 mm high and weighs approximately two kilograms. The test kit comes with stoppered vials holding freeze-dried luminous bacteria, hydration buffer, storage buffer, Pro-Metal concentrated assay buffer, Pro-Organic concentrated assay buffer, concentrated positive control solutions, and empty test tubes. The portable luminometer costs \$3,950, and a starter kit including reagents for 1,000 single tests costs \$550.

<http://www.epa.gov/etv/verifications/vcenter1-27.html>

Environmental Technology Verification Report: Environmental Bio-Detection Products Inc., Toxi-Chromotest

Schrock, M., R. James, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 39 pp, June 2006

The Toxi-Chromotest detects toxic substances in water, chemicals, pharmaceuticals, food, and body fluids. The Toxi-Chromotest is a bacterial assay based on the ability of toxic materials and antibiotics to inhibit the de novo synthesis of an inducible enzyme, beta-galactosidase, in a strain of the bacteria, E. coli (K12 OR85). The bacteria in the Toxi-Chromotest are exposed to stressing conditions and freeze dried. To test for toxicity, the bacteria are mixed with a rehydration cocktail containing inducers of the enzyme beta-galactosidase and factors necessary for the recovery of the bacteria from their stressed condition. During the recovery phase, toxicants present at sufficient concentrations penetrate the cell walls of the bacteria and inhibit the de novo synthesis of the beta-galactosidase. The rate of production of the induced enzyme is detected by a reaction of the excreted enzyme with a chromogenic substrate in the bacterial suspension that was exposed to the potential toxicant. Toxic materials above threshold levels interfere with the production of the enzyme and decrease color formation. The Toxi-Chromotest kit includes a reaction mixture (the cocktail containing an inducer for the enzyme beta-galactosidase and co-factors required for the recovery of the bacteria from their stressed condition), lyophilized bacteria, rehydration solution, a positive control (4 ug/L of mercuric chloride in water), a chromogenic substrate (blue chromogen cocktail, ready for use), and diluent for the positive control and test samples. In addition, the Toxi-Chromotest kit contains three 96-well microtiter plates and biohazard bags. The user must supply a micropipette for adding the test samples, rehydrated bacteria, and chromogenic substrates to the test wells and an incubator in which the plates containing the bacteria are allowed to recover and begin to produce the enzyme that reacts with the added chromogenic substrate. The incubator must maintain a constant temperature of 37 degrees C during the 90-minute incubation period. The Toxi-Chromotest is supplied in a Styrofoam box (25 x 13 x 8 cm) that contains the 96 well plates, the biohazard bags for disposal of test materials, and all of the necessary reagents to carry out three separate analytical test series. For field use, a 15 x 15 x 15-cm incubator can be supplied that runs off a 12-volt battery or 120-volt alternating current. The output from the Toxi-Chromotest can be measured in the laboratory by absorbance at 615 nanometers using a plate reader. If the test is conducted in the field or a plate reader is not available (as during this test), the results can be read by visually recording the intensity of blue color produced against an internally run set of standards to obtain a relative toxicity reading. The standard Toxi-Chromotest

kit, with reagent, bacteria, and plates to run the tests in the three 96-well microtiter plates provided, sells for \$375.

<http://www.epa.gov/etv/verifications/vcenter1-27.html>

Environmental Technology Verification Report: Lab_Bell Inc., LuminoTox PECs Test Kit
Schrock, M., R. James, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 49 pp, June 2006

The LuminoTox PECs Test Kit is a portable biosensor that indicates the presence of toxic chemicals in water. It uses PECs that have been stabilized through a method patented by Lab_Bell Inc. The PECs are membranes isolated from chloroplasts that are as simple to use as a chemical, but react more rapidly than a living organism because toxic compounds do not have to penetrate the cell wall of an organism. The photosynthetic electron chain is what is inhibited by contamination. When stimulated by light, the PECs emit fluorescence. The LuminoTox PECs Test Kit measures the fluorescence parameters produced both in background water and samples containing contaminants. Decreases in fluorescence parameters as a result of the presence of toxic contamination are expressed as percent inhibition. The LuminoTox PECs Test Kit consists of the LuminoTox analyzer, a bottle of PECs for 50 tests, reaction buffer, a blank water control, and a positive control. Also provided are disposable syringes in which the test is performed and fabric syringe covers to protect the reaction from light. Aluminum foil can be used as a light protector. The LuminoTox analyzer is 21.6 x 12.7 x 7.6 cm and weighs 1 kg. It is battery-operated and portable. The analyzer has a built-in RS-232 serial port outlet, which can also be used for transferring data to a spreadsheet (which was not done during this test), and is compatible with a printer. A total of 100 measurements can be stored in the internal memory. The rechargeable battery operates for eight hours. Each kit costs \$89, and the analyzer costs approximately \$7,500.

<http://www.epa.gov/etv/verifications/vcenter1-27.html>

Environmental Technology Verification Report: Lab_Bell Inc., LuminoTox SAPs Test Kit
Schrock, M., R. James, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 49 pp, June 2006

The LuminoTox SAPs Test Kit is a portable biosensor that uses SAPs activated by light absorption to recognize toxic chemicals in water. SAPs are activated at a wavelength of 470 nanometers, and fluorescence emission is read at wavelengths longer than 700 nanometers. SAPs are whole algae (*Chlorella vulgaris*) that fluoresce when photosynthesis (the conversion of electromagnetic energy into stored chemical energy) is activated by light absorption. Some of the absorbed energy is emitted as fluorescence, which is the signal measured by the LuminoTox SAPs Test Kit. The photosynthetic electron chain is inhibited by a broad spectrum of organic molecules (ureas, azides, phenols, quinones or amide derivatives, polyaromatic hydrocarbons, polychlorinated biphenyls), redox species, cyanides, and metallic cations. The LuminoTox SAPs Test Kit measures the fluorescence produced both in background water and samples containing contaminants. Decreases in fluorescence as a result of adding toxic contamination are expressed as percent inhibition. Though other SAPs could be used in the LuminoTox analyzer, Lab_Bell uses *Chlorella vulgaris*, which is concentrated by centrifugation in the middle of its exponential growth curve and stored at 4 degrees C for a few weeks. Prior to analysis, SAPs must be

activated in room light for 90 minutes at ambient temperature. The LuminoTox test is performed in the dark (in a covered syringe) by exposing 100 microliters of SAPS solution to 2 milliliters of test sample for 10 minutes. In this short period of time, permeable molecules acting directly on the photosynthetic electron chain are detected at low concentrations. Prolonged incubation allows the detection of less permeable molecules. The LuminoTox SAPS Test Kit consists of the LuminoTox analyzer, a bottle of SAPS for 50 tests, two vials of organic standards (positive controls to ensure that the SAPs are fully functional), and one vial of distilled water (for blank samples). Also provided are disposable syringes in which the test is performed and fabric syringe covers to protect the reaction from light. The analyzer is 21.6 x 12.7 x 7.6 cm and weighs 1 kg. The analyzer is battery-operated and equipped with a RS-232 serial port for transferring data, and can be connected to a printer (not done during this test). A total of 100 measurements can be stored in the internal memory. The rechargeable battery operates for eight hours. Reagents (including buffers and positive and negative controls) for approximated 50 analyses cost \$106, while the LuminoTox analyzer costs approximately \$7,500.

<http://www.epa.gov/etv/verifications/vcenter1-27.html>

Environmental Technology Verification Report: Strategic Diagnostics Inc., RAPIDTOXKIT Schrock, M., R. James, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 53 pp, June 2006

The RAPIDTOXKIT uses larvae of the anostracan crustacean *T. platyurus* to detect freshwater (including drinking water) contamination. The RAPIDTOXKIT bioassays are performed in disposable test tubes using *T. platyurus* hatched from cysts. Cyst hatching must begin 30 to 45 hours prior to performing the test. The *T. platyurus* are exposed to samples for 15 minutes to one hour, after which a suspension of red microspheres is added. The organisms ingest the microspheres, resulting in a deep red color in their digestive tracts. Stressed (intoxicated) organisms either fail to take up particles altogether or ingest at a much lower rate. The presence or the absence of colored microspheres in the digestive tract of the larval crustaceans is observed under a stereomicroscope, and data are recorded on a sheet supplied with the RAPIDTOXKIT. The total number of *T. platyurus* in the control (standard freshwater) well(s), and the number of *T. platyurus* that have taken up the red particles are counted, and the fraction of larval crustaceans affected by the contaminant is defined as the percent inhibition. As a guideline, 30% inhibition of particle uptake is considered a threshold for the presence of potentially toxic compounds in the water. Each test kit includes three 1-mL test tubes containing cysts of *T. platyurus*, one bottle of standard freshwater, 3 hatching vessels, 6 sub-sampling tubes, 48 test tubes, 6 test-tube holders, one vial with red microspheres, one vial with fixative, 6 observation plates, 6 transparent covers for observation plates, a blue plastic sheet and grid designed to be placed under plates to aid in observing and scoring test organisms, standard operating procedure booklet, bench protocol, 6 sheets for scoring test results and calculating mean inhibition of particle uptake, and a specification sheet containing batch numbers and shelf lives of kit components. Materials required but not provided as part of the kit include a 25 degrees C incubator with 4,000-lux constant illumination, a dissection microscope with minimum 10X magnification, and an overhead light source for the microscope. The complete RAPIDTOXKIT, adequate for 7 to 15 water samples each, depending on the sample size, measures 30 x 25 x 10 cm and costs \$196.

<http://www.epa.gov/etv/verifications/vcenter1-27.html>

Environmental Technology Verification Report: bm becker messtechnik gmbh, AMESA (Adsorption Method for Sampling Dioxins and Furans)

Cowen, K., T. Kelly, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 38 pp, June 2006

The AMESA long-term sampling apparatus is based on the isokinetic sampling of flue gas and the adsorption of PCDD, PCDF, and other persistent organic pollutants on an exchangeable adsorption-resin-filled cartridge. The AMESA system consists of a titanium sampling probe with probe shaft and heat exchanger, a cartridge unit as a collection point, and a control cabinet. The titanium probe is used for both the isokinetic sampling and cooling of the hot flue gas to less than 50 degrees C. The cooled flue gas, together with any accumulated condensate, is fed into the cartridge filled with adsorption resin (XAD-2) via an upstream quartz wool filter. Flue gas conditions are monitored using sensors in the probe and are used by the control unit to adjust sampling rates to maintain isokineticity. The PCDD/Fs can be collected over a period of up to one month and then analyzed in a laboratory. All data required for the subsequent determination of the mass concentration are gathered automatically and stored on a static random-access memory card. In addition to this ETV verification test, other evaluations of the AMESA system have been completed. The AMESA system was approved by the German Technical Inspection Authority in 1997, received the MCerts certification in October 2005, and participated in a performance test for the Taiwanese EPA in 2001. During these tests many validation measurements against the respective standard methods were done. The AMESA has also been deployed in approximately 100 applications. Results from these other tests and applications are available from the vendor.

<http://www.epa.gov/etv/verifications/vcenter1-37.html>

Environmental Technology Verification Report: IDX Technologies, Ltd., RIMMPA-TOFMS (Resonance Ionization with Multi-Mirror System Photon Accumulation Time-of-Flight Mass Spectrometer)

Cowen, K., T. Kelly, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 62 pp, June 2006

The RIMMPA-TOFMS is a new laser-based mass spectrometry system developed for the real-time detection and quantification of PCDD/Fs. The RIMMPA-TOFMS is based on a two-color/two-photon ionization scheme and employs a nanosecond pulse duration that promotes isomer selective soft ionization with high sensitivity. The technology consists of a Nd:YAG pumped dye laser including frequency doublers (tuning range between 270 to 370 nanometers, 5 to 8 nanosecond pulse width, 10 Hz repetition rate, under 0.1 centimeter(-1) at 285 nanometer optical linewidth, 2 mJ maximum output energy for exciting sample molecules, a frequency quintupled Nd:YAG laser (213 nm laser radiation, 3 to 5 nanosecond pulse width, 10 Hz repetition rate, 4 mJ maximum output energy) for ionizing excited molecules, and a multi-mirror system by which an optical image relaying system is constructed using 14 reflective mirrors. A pulsed valve developed for operation under a high-temperature condition is used in the RIMMPA-TOFMS to produce a supersonic jet under the choke-flow condition. This supersonic jet allows the sample gas to be cooled to cryogenic temperatures and generates uniform ordering of the gaseous molecules so that the collisions between particles are minimized, which extends the excitation lifetime of the target compounds. The supersonic molecular beam interacts with the two multi-reflected synchronous laser beams for about 40 nanoseconds in the ionization

region, where the target molecules are selectively ionized and accelerated into the time-of-flight mass spectrometer.

<http://www.epa.gov/etv/verifications/vcenter1-37.html>

Environmental Technology Verification Report: Monitoring Systems GmbH,
DioxinMonitoringSystem

Cowen, K., T. Kelly, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 38 pp, June 2006

The DioxinMonitoringSystem is a long-term sampling device for measuring the concentrations of PCDDs in gas streams. It is an automatic isokinetic sampler for measurement of PCDDs, PCDFs, and other persistent organic pollutants. The system comprises (1) a stack-mounted dual probe system includes automatic probe switching, blowback, and cleaning, with particle filter and polyurethane foam (PUF) cartridge housing attached and (2) a remote control unit for isokinetic sampling enabling automatic measurement control, remote control and data download, standby/restart, and calibration. The control unit contains both menu-driven software and a process computer. The computer monitors the function of all aggregates and registers all data required for the subsequent evaluation of the samples taken. At regular intervals, data are stored on a static random access memory (SRAM) card. The data on the SRAM card are later interrogated with the analysis results to ascertain the mass concentration. The gas is sampled isokinetically from the gas stream by alternating the use of one of two titanium probes. The collected gas is transferred to a titanium mixing chamber where it is diluted with dried and cooled air. The sampled gas is cooled by keeping the dew point below the gas mixture temperature, which avoids any condensation. The dry gas mixture then passes through a filter stack where the PCDDs are collected. The filters are designed to collect the dust fraction and the gas (or more exactly, the material passing through the filter) fraction separately. The DioxinMonitoringSystem allows most of the sampling to be conducted unattended after an initial run configuration by the operator. This device is specifically configured to the sampling location on installation, partially by the sampling institution or laboratory preparing and analyzing the cartridges and partially by the operator. The system can also be configured as a single probe device. Both configurations can handle high dust loadings (up to 150 milligrams per cubic meter) without change in performance, and flue gas velocities up to 30 meters per second can be accommodated within the isokinetic control range of the overall system. The system can also be configured to collect samples for determining heavy metals.

<http://www.epa.gov/etv/verifications/vcenter1-37.html>

Environmental Technology Verification Report: SRI International, Jet-REMPI (Resonance Enhanced Multi-Photon Ionization)

Cowen, K., T. Kelly, A. Dindal, Z. Willenberg, and K. Riggs, Battelle.

U.S. EPA, ORD, Environmental Technology Verification Program, 36 pp, June 2006

Jet-REMPI is an analytical technique designed to selectively identify and quantify vapor-phase constituents present at part-per-trillion levels in incinerator emissions without preconcentration or sample collection. Ions produced by REMPI are typically detected using a time-of-flight mass spectrometer (TOFMS) that takes advantage of the pulsed nature and well-defined temporal character of laser ionization. Simultaneous detection by mass and wavelength

yields the extremely high chemical selectivity crucial to identifying one trace compound amidst many similar ones. The laser system used in the verification test consists of a Nd:YAG pumped OPOTEK Vibrant OPO with frequency doubling unit with a nominal tuning range between 250 and 340 nanometers, a 5-nanosecond pulse width, and a repetition rate of 10 hertz. The optical line width of the system is approximately 2 centimeters (cm)-1. The pulsed valve is an unmodified General Valve Series 9 unit, with an orifice diameter of 0.5 millimeter. The nominal opening time was 150 microseconds, with a 2.5-cm separation between the exit of the valve and the ionization region. With the sample reservoir at atmospheric pressure, the two 250-liters-per-second turbomolecular pumps (Varian Turbo V-250) maintain pressures in the ionization chamber and mass spectrometer regions of 10^{-5} Torr, and 5×10^{-7} Torr, respectively. The mass spectrometric capabilities of the reflectron-type TOF mass analyzer used in this verification test include an upper mass range typically up to 500 atomic mass units and mass resolution ($m/\Delta m$) greater than 500.

<http://www.epa.gov/etv/verifications/vcenter1-37.html>

EPA/MoDNR Pilot Project: Characterizing Environmental Contamination Through Airborne Hyperspectral Imaging

Missouri Department of Natural Resources website, 2006.

Following the accidental or deliberate release of hazardous materials or the dispersion of hazardous materials through a natural or man-made disaster, it is critical to locate, characterize, and identify the contamination as quickly as possible. Many substances have a unique spectral signature that can be used for identification. Hyperspectral imagery (HSI) sensors have been used for a variety of environmental applications. Missouri, other states, and federal agencies will soon have access to airborne HSI through the Civil Air Patrol's (CAP) Airborne Real-Time Cueing Hyperspectral Enhanced Reconnaissance (ARCHER) program. Headquarters CAP National Technology Center is deploying 16 ARCHER-configured aircraft that will be stationed in CAP regions for Homeland Security, disaster relief, search and rescue, and other to-be-defined missions. With a grant from U.S. EPA, the Missouri Department of Natural Resources is pursuing a Pilot Project to evaluate environmental applications of ARCHER to the department's missions of Environmental Emergency Response, characterizing contamination over wide areas, and assessing other impacts to the environment. The project time frame was October 1, 2004 through September 30, 2005. This website provides reports and other information on site development, HSI collection, and pilot project results.

<http://dnr.mo.gov/env/hwp/hsi/hsi-project.htm>

Equilibrium Partitioning of Non-Sequestered Fractions of Hydrophobic Organic Chemicals Between Sediment, Pore Water and Benthic Deposit-Feeders (Tubificidae)

Mayer, P., F. Busser, M. van het Bolscher, and W. Seinen (Univ. of Utrecht); A. Belfroid (TNO Voeding, Delft, The Netherlands); J. Tolls (Univ. of Utrecht).

Sequestration and Bioavailability of Hydrophobic Chemicals in Sediment, Chapter 5, p 59-75, 2001

The authors tested equilibrium partitioning of non-sequestered, rapidly desorbing compounds between sediment, porewater, and tubificidae. They determined freely dissolved concentrations of a range of hydrophobic organic compounds (chlorobenzenes and PAHs) in

porewater using matrix-SPME and bioconcentration factors for tubificidae in water. These data were employed to interpret measurements on bioaccumulation in tubificidae and sequestration in sediment. Bioaccumulation based on equilibrium partitioning was estimated by multiplying the porewater concentrations and the bioconcentration factors. The freely dissolved concentrations in the pore water were proportional to the concentrations of rapidly desorbing compounds, confirming linear sorption behavior for the rapidly desorbing compartment. Steady-state accumulation of the target compounds in benthic deposit-feeders can be fully reconciled with equilibrium partitioning of rapidly desorbing compounds between sediment, porewater, and deposit-feeders. The bioaccumulation of sediment-associated hydrophobic organic compounds in deposit feeders can be estimated from measurements of freely dissolved concentrations in porewater.

<http://igitur-archive.library.uu.nl/dissertations/1960191/c5.pdf>

ESTCP Air Monitoring Technology Used at U.S. Open Golf Tournament
SERDP Information Bulletin, p 7, Fall 2005

As a precautionary measure, the North Carolina State Bureau of Investigation (SBI) requested that the North Carolina Division of Air Quality (DAQ) conduct ambient air monitoring during the U.S. Open Golf Tournament held in Pinehurst, NC, June 12-19, 2005. The purpose was to provide early warning of any toxic air release to protect 50,000 fans. The DAQ worked with the NC SBI and U.S. Golf Association officials to monitor the ambient air using various single-point chemical analyzers, on-site gas chromatography/mass spectroscopy systems, and path-integrated optical remote sensing using Open Path Fourier Transform Infrared (OP-FTIR) spectroscopy. This technology was originally demonstrated with ESTCP funding under project SI-0214, Optical Remote Sensing Method to Determine Strength of Nonpoint Sources. The ESTCP project demonstrated standardized nonpoint source measurement methods based on path-integrated optical remote sensing (PI-ORS) and computed tomography as developed by ARCADIS for DoD in Research Triangle Park, NC. The North Carolina DAQ recently purchased this technology. The DAQ used the OP-FTIR technology to monitor for toxic airborne chemicals along a strategically selected section of the perimeter at the tournament site. The ambient air was monitored for 40 compounds in near-real time. Compounds of interest included common industrial chemicals that might be accidentally released, such as ammonia or gasoline vapors, as well as vapor-phase chemicals that could be released intentionally as part of a terrorist act, such as chemical warfare agents. The SBI was in charge of security for the golf tournament and requested DAQ's help on behalf of the U.S. Golf Association, which had arranged for air monitoring at previous tournaments.

Evaluating an Enzyme Bioassay for the Purpose of Screening Mining Impacted Soils (MIS) for Metals Contamination

Blumenstein, E.P. and J.F. Ranville (Colorado School of Mines, Golden); L.M. Choate (USGS, Denver, CO). The 10th Billings Land Reclamation Symposium--Reclamation: Supporting Future Generations, 4-8 June 2006. BLRS and ASMR, Lexington, KY. p 44, 2006

Toxicity of mine tailings piles and abandoned mine soils traditionally has been determined by either the toxicity characteristic leaching procedure (TCLP) or traditional toxicity tests using organisms, such as *Ceriodaphnia dubia*. Enzymatic bioassays can provide an easier,

less costly, and more time-effective toxicity screening procedure for mine tailings and abandoned mine soil leachates. Researchers evaluated MetPLATE(tm), a commercially available enzymatic toxicity assay that uses a modified strain of the Escherichia coli bacteria as the test organism. When the E. coli bacteria are not stressed, they produce the enzyme beta-galactosidase, which cleaves a chromogenic substrate. When the E. coli bacteria are stressed, they produce less enzyme, which decreases the amount of substrate cleaved. The inhibition of the enzyme can be measured colorometrically with a 96-well spectrophotometer. The MetPLATE(tm) assay shows actual toxicity by taking into account the bioavailability of metals in solution, requires a very short testing period (~2 hours), contains 100,000+ organisms per sample concentration, and eliminates the need for an organism culture. Similar effects of water chemistry variations (hardness, alkalinity, and dissolved organic carbon) are seen with the MetPLATE™ assay E. coli as are seen with C. Dubia.

Evaluation of Methods for Measurement and Prediction of Porewater Concentrations of Gasoline Compounds, Trichloroethylene and Phenanthrene in the Unsaturated Zone
de Jonge, H. (Danish Inst. of Agricultural Sciences, Tjele), M.O. Kjærgaard, P. Moldrup, and K. Dahlstrom. EEGS XXVII General Assembly, Nice, France, April 2002

Existing methods are compared for measuring and/or predicting the porewater concentration of gasoline, BTX components, trichloroethene, and phenanthrene. The evaluated methods include traditional soil sampling/extraction, suction lysimeters, pore gas sampling, and aqueous batch extraction. The evaluated modeling approaches include fugacity calculations, quasi-static gasdiffusion calculations, and dynamic gas diffusion/solute transport modeling (HYDRUS-1D)¹. The results obtained will cover the different sampling techniques with respect to their accuracy, reproducibility, and practical applicability for regulatory purposes. In addition, the predictive value of the different modelling approaches will be evaluated with respect to the multiple solutes contamination and flow scenarios performed in the lysimeter studies.

Evaluation of Potential Vapor Transport to Indoor Air Associated with Small-Volume Releases of Oxygenated Gasoline in the Vadose Zone
Matthew A. Lahvis, Shell Global Solutions (US) Inc.

American Petroleum Institute, API Soil and Groundwater Research Bulletin No. 21, 4 pp, 2005

Potential human exposure from vapor transport to indoor air is evaluated for small-volume releases of oxygenated gasoline in the vadose zone at underground storage tank (UST) sites. For this analysis, potential human exposure is defined by model simulation as the distance at which benzene concentrations exceed 3.1 ug/cubic meter, a proposed 10(-6) risk-based screening level for shallow soil gas. Transport in the vadose zone was simulated assuming one- and two-dimensional model geometries, a range of biodegradation rates, and conservative (default) model parameters. Under anaerobic conditions, benzene is predicted to exceed the risk-based screening level in the vadose zone at distances ranging from approximately 55 to 100 ft from the source, depending primarily on model geometry. If benzene biodegradation is linked to oxygen availability, the distance over which there is a potential for risk reduces to less than 10 ft. Considering that the distances to nearest receptor will likely exceed model predicted estimates at most UST sites and that anaerobic conditions will be limited in extent in soils conducive to vapor

transport, small-volume releases of oxygenated gasoline are not expected to pose a significant risk for vapor intrusion at UST sites.

http://api-ec.api.org/filelibrary/21_Bull.pdf

Evaluation of the Efficiency of Various Commercial Products for the Bioremediation of Hydrocarbon Contaminated Soil

Claassens, S., L. Van Rensburg, K.J. Riedel, J.J. Bezuidenhout, and P.J.J. Van Rensburg, North-West Univ., Potchefstroom, South Africa.

Environmentalist, Vol 26 No 1, p 51-62, 2006

Enzymatic analyses and signature lipid biomarkers were successfully applied to an evaluation of the efficacy of selected bioremediation products on oil-contaminated soil plots. The enzymatic assays provided valuable insight into shifts in the functional diversity of the soil microbial communities that resulted from the various treatments. Stimulation or inhibition of the microbial communities as a result of the various treatments was also demonstrated, particularly with regard to dehydrogenase activity. Phospholipid fatty acid profiles were sufficiently sensitive to allow differentiation between products and resultant microbial communities that corresponded to satisfactory and unsatisfactory petroleum hydrocarbon removal.

Explorative and Innovative Dynamic Flux Bag Method Development and Testing for Mercury Air/Vegetation Gas Exchange Fluxes

Zhang, H.H., L. Poissant, X. Xu, and M. Pilote.

Atmospheric Environment, Vol 39 No 39, p 7481-7493, 2005

A field study quantifying total gaseous mercury (TGM) and mercury speciation fluxes in a wetland ecosystem was conducted in summer 2003 in Canada. The study involved an innovative approach, a dynamic flux bag (DFB) technique to measure in situ mercury air/vegetation exchange with a monoculture of river bulrush. The data indicate that TGM air/vegetation exchange is bidirectional; however, the net flux is primarily featured by dry deposition of TGM from atmosphere to the vegetation. Examination of mercury speciation using the DFB approach showed that particulate mercury (PM) and reactive gaseous mercury (RGM) represented less than 1% of total mercury. The authors discuss the similarities and discrepancies between the DFB and other approaches, such as dynamic flux chamber and modified Bowen ratio. Some operational effects associated with the bag design were noted during the study, mainly the emergence of condensation within the bag, and improvements to the DFB design are suggested. The DFB method shows great promise as a technique to study the role of a single plant in air/vegetation exchange of mercury.

Fabrication of Microelectrode Arrays for In Situ Sensing of Oxidation Reduction Potentials

Lee, J.-H.; A. Jang; P.R. Bhadri; R.R. Myers; W. Timmons; F.R. Beyette Jr.; P.L. Bishop; I. Papautsky (Univ. of Cincinnati, Cincinnati, OH).

Sensors and Actuators, B: Chemical, Vol 115 No 1, p 220-226, 23 May 2006

This paper describes fabrication of microelectrode sensor arrays for measurements of oxidation-reduction potential (ORP) in situ during environmental monitoring. The four-probe microelectrode arrays were fabricated from glass using a two-step, HF-based meniscus etching

process. The tip size of individual microelectrodes was approximately 200 nm. When compared with commercial milli-electrodes, the microelectrode arrays exhibited very fast response time (from a few milliseconds to 30 s) and proved to be extremely stable.

FIA-Fluorimetric Determination of the Pesticide 3-Indolyl Acetic Acid
Calatayud, J.; J. Ascencao; J. Albert-Garcia.

Journal of Fluorescence, Vol 16 No 1, January 2006, p 61-67(7)

The determination of 3-indolyl acetic acid (a pesticide) based on its native fluorescence is discussed. The method was optimized in either a flow injection analysis (FIA) assembly or in batch. The investigators examined a large series of potential interferents and finally applied the method to water samples.

Field Studies of Oxygen and Hydrocarbon Vapor Transport Beneath and Around Buildings
Located over NAPL Sources

Luo, E.H., P. Dahlen, and P. Johnson (ASU); T. Peargin (Chevron); T. Creamer (Trihydro); P. Lundegard (Lundegard and Associates); B. Hartman (HP Labs); T. McAlary and L. Abreu (GeoSyntec). EPA/AEHS, 16 March 2006, San Diego - A Summary Workshop in the Context of EPA's VI Guidance Revisions. PowerPoint presentation, 27 pp.

Abstract not available.

<http://iavi.rti.org/attachments/WorkshopsAndConferences/1540 - Johnson.pdf>

Field Testing of Remote Sensor Gas Leak Detection Systems

U.S. DOE, Rocky Mountain Oilfield Testing Center (RMOTC), Casper, WY. 261 pp, Dec 2004

The natural gas pipeline industry routinely checks their pipeline right-of-way areas to ensure that leaks are detected. Pipeline companies use various processes to detect signs of leaking pipes, including using vehicles or low-flying aircraft. The leak detection methods range from directly sensing the gas to looking for indirect signs of leakage. To aid in the development and availability of remote detection systems, DOE and DOT funded the field testing of five remote sensor leak detection systems, one each from EnUrga Inc., ITT Industries, Inc., LaSen, Inc., Lawrence Livermore National Laboratories, and Physical Sciences, Inc. The technologies included passive infrared multi-spectral scanning, laser-based differential absorption lidar, hyperspectral imaging, and tunable diode laser absorption spectroscopy (TDLAS). The sensor systems were mounted in an unmodified automobile, a helicopter, or a fixed-wing aircraft. This report details the testing project conducted at the Rocky Mountain Oilfield Testing Center field site along a "virtual pipeline" 7.5 miles in length.

http://www.rmotc.com/pdfs/SwRI_Final.pdf

Fine Particle Emission Profile for a Large Coke Production Facility Based on Highly Time-Resolved Fence Line Measurements

Weitkamp, E.A., E.M. Lipsky, P.J. Pancras, J.M. Ondov, A. Polidori, B.J. Turpin, and A.L. Robinson.

Atmospheric Environment, Vol 39 No 36, p 6719-6733, Nov 2005

A fine-particle emission profile for a large metallurgical coke production facility was developed from time-resolved, ambient air quality measurements made at a fence line site adjacent to the plant. A fence line approach was employed because the coke plant has hundreds of stacks and other emission points, making it difficult to develop an integrated, facility-wide emission profile using stack sampling techniques. Continuous or semi-continuous measurements were made of PM_{2.5} mass, PM₁₀ mass, SO₂, NO_x, organic and elemental carbon (OC and EC), particle size and number, 11 trace metals, wind direction, wind speed, and background pollutant levels. Highly time-resolved measurements are essential to resolve large spikes in pollutant concentrations of relatively short duration.

Flight Testing of an Advanced Airborne Natural Gas Leak Detection System
Lenz, D., R.T. Lines, D. Murdock, J. Owen, S. Stearns, and M. Stoogenke.
ITT Industries Space Systems Division, 84 pp, Oct 2005

ITT Industries Space Systems Division has developed an airborne natural gas leak detection system designed to detect, image, quantify, and precisely locate leaks from natural gas transmission pipelines. This system is called the Airborne Natural Gas Emission Lidar (ANGEL) system. ANGEL uses a highly sensitive differential absorption lidar technology to remotely detect pipeline leaks. The system is operated from a fixed-wing aircraft and includes automatic scanning, pointing, and pilot guidance systems. During a pipeline inspection, the ANGEL system aircraft flies at an elevation of 1,000 feet above the ground at speeds of between 100 and 150 mph. Under Award No DE-FC26-03NT41877 with DOE/NETL, Space Systems was funded to integrate the ANGEL sensor into a test aircraft and conduct a series of flight tests over a variety of targets, including simulated natural gas pipeline leaks. Following early tests in upstate New York in the summer of 2004, the ANGEL system was deployed to Casper, WY, to participate in a set of DOE-sponsored field tests at the Rocky Mountain Oilfield Testing Center (RMOTC). At RMOTC, the Space Systems team completed integration of the system and flew 2 missions per day for the duration for the 5-day test. Over the course of the week, ANGEL detected leaks ranging from 100 to 5,000 scfh.

http://www.netl.doe.gov/technologies/oil-gas/publications/td/41877_final.PDF

A Flow Injection Voltammetric Electronic Tongue Applied to Paper Mill Industrial Waters
Gutes, A., F. Cespedes, and M. del Valle (Autonomous Univ. of Barcelona, Bellaterra, Spain);
D. Louthander, C. Krantz-Rulcker, and F. Winquist (Linkoping Univ., Linkoping, Sweden).
Sensors and Actuators, B: Chemical, Vol 115 No 1, p 390-395, 23 May 2006

A voltammetric electronic tongue with automated operation based on the flow injection (FIA) technique was applied to the characterization of paper mill wastewaters. A metallic multielectrode array comprising platinum, gold, and rhodium electrodes was employed as the detection system, while the measurements were based on large amplitude pulse voltammetry. Samples were first discriminated using principal component analysis, while artificial neural networks were used for the characterization and prediction of chemical oxygen demand, conductivity, and pH.

A Fluorescence-Based Biosensor for the Detection of Organophosphate Pesticides and Chemical Warfare Agents

Viveros, S. Paliwala, D. McCraec, J. Wildb and A. Simoniana

Sensors and Actuators B: Chemical, Vol 115 No 1, p 150-157, 23 May 2006

A rapid, fiber-optic biosensor assay developed for the direct detection of organophosphates utilizes organophosphate hydrolase (OPH), an enzyme, for the biorecognition element. The OPH was conjugated with biotin (to anchor it) and carboxynaphthofluorescein (CNF) as a fluorescence reporter. Avidin was attached to the polystyrene waveguide surface of a fluorescent detector, and the OPH/CNF/biotin biosensor conjugate was bound to the avidin. Quantitative detection was determined from 1 to 800 μM for paraoxon and from 2 to 400 μM for DFP. In addition, the system could also be used to provide continual remote monitoring and spectral fluorescent notification. The system could also be used for continual remote monitoring and spectral fluorescent notification.

<http://www.eng.auburn.edu/~simonal/Simonian%20articles%20PDF/2006%20Sens.%20Actuat.B,%20fluorescence-based%20biosensor%20for%20OP's,%20Leamon.pdf>

Fluorescent DNAzyme Biosensors for Metal Ions Based on Catalytic Molecular Beacons

Liu, Juewen and Yi Lu, Univ. of Illinois at Urbana-Champaign.

Methods in Molecular Biology: Fluorescent Energy Transfer Nucleic Acid Probes: Designs and Protocols. Humana Press: Totowa, NJ, p 275-288, 2006

Methods are discussed for designing metal ion sensors using fluorophore- and quencher-labeled DNAzymes that utilize catalytic cleavage to release the fluorophore for detection and quantification, making it possible to take advantage of catalytic turnovers for signal amplification. The methods are based on the finding that almost all known trans-cleaving DNAzymes share a similar structure comprising a catalytic DNAzyme core flanked by two substrate recognition arms. The design of highly sensitive and selective Pb^{2+} sensors is described, using the "8-17" DNAzyme as an example. The initial design employs a single fluorophore/quencher pair in close proximity, with the fluorophore on the 5'-end of the substrate and the quencher on the 3'-end of the enzyme. Although this sensor is highly sensitive and selective at 4 degrees C, high background fluorescence is observed at higher temperatures, so a new design with an additional quencher attached to the 3'-end of the substrate is employed to suppress background fluorescence. The dual quencher method allows the sensor to perform at ambient temperatures with a high signal-to-noise ratio.

<http://montypython.scs.uiuc.edu/paper.htm>

Fractionation and Sequential Extraction of Heavy Metals in the Soil of Scrapyard of Discarded Vehicles

Jaradat, Q.; A. Massadeh; M. Zaitoun; B. Maitah.

Environmental Monitoring and Assessment, Vol 112 Nos 1-3, p 197-210, Jan 2006

Chemical and physical size fractionation of heavy metals was carried out on 20 soil samples from a vehicle scrap yard. The Tessier method was used in sequential extraction. The authors describe the results.

Freely Dissolved Concentrations of PAHs in Soil Pore Water: Measurements via Solid-Phase Extraction and Consequences for Soil Tests

ter Laak, Thomas L. (IRAS, Utrecht Univ., Utrecht, The Netherlands), Stanley O. Agbo, Arjan Barendregt, and Joop L. M. Hermens.

Environmental Science & Technology, Vol 40 No 4, 1307-1313, 2006

A negligible-depletion, partitioning-based sampling technique was applied to measure freely dissolved pore water concentrations. When a poly(dimethylsiloxane) (PDMS)-coated glass fiber was exposed to a slurry of a soil spiked with several PAHs at concentrations ranging from 2 to 2,000 mg/kg, PAH concentrations in the PDMS coating increased linearly with the total soil concentration until a certain maximum was reached. Freely dissolved pore water concentrations were calculated using PDMS-water partition coefficients, and the calculated maximum pore water concentrations corresponded with the aqueous solubility of the tested compounds. The sampling technique can detect freely dissolved pore water concentrations in the ng/L range for the tested PAHs.

Fugitive Mercury Emissions from a Chlor-Alkali Factory: Sources and Fluxes to the Atmosphere

Southworth, G.R., S.E. Lindberg, H. Zhang, and F.R. Anscombe.

Atmospheric Environment, Vol 38 No 4, p 597-611, Feb 2004

Fugitive (non-stack) mercury air emissions at a U.S. chlor-alkali were investigated during winter 2000 using a variety of sophisticated mercury vapor analyzers: a Tekran 5-min integrated sampler modified for cell-room use, Lumex RA915+ and Jerome 431-X portable Hg analyzers, and a long-path integrating DOAS system for gaseous elemental Hg, coupled with an optical anemometer for measuring vent-averaged air flow rates. Mercury data were obtained over a 9-day period from inside the factory, with concurrent awareness of manufacturing operations, and emissions were measured from the roof vent, the open-sided basement below the production cells, and surrounding soils and sealed waste ponds. The integrated beam (DOAS) and point measurements of Hg compared well. The investigators found that fugitive air emissions from the cell-room roof vent are episodic and vary with factory operating conditions. Properly positioned, real-time mercury vapor analyzers have great potential as tools for locating small-scale process leaks and estimating overall emissions. The sealed waste ponds emitted Hg at rates comparable to background soils.

Gain-Swept Superradiance Applied to the Stand-Off Detection of Trace Impurities in the Atmosphere

Kocharovsky, V. (Texas A&M University, College Station), S. Cameron, K. Lehmann, R. Lucht, R. Miles, Y. Rostovtsev, W. Warren, G.R. Welch, and M.O. Scully.

Proceeding of the National Academy of Sciences USA, Vol 102 No 22, p 7806-7811, 31 May 2005

Gain-swept superradiance can be used to detect low (parts per million) concentrations of various gases at distances on the order of kilometers, which is done by using pulse timing to create small regions of gain at positions that sweep toward a detector. The technique is far more sensitive than previous methods, such as light detection and ranging (lidar) or differential absorption light detection and ranging.

<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1142365>

Gas-Plume Imager Scans Refineries in Field Testing

Garcia, Nancy.

Sandia Lab News, Vol 55 No 24, 28 Nov 2003

A gas-plume imager developed at Sandia has left the lab and entered the field in the past year, undergoing refinery field tests from California to England. The tests suggest that imaging technology is a viable alternative to hand-held sniffers currently used to detect leaks. U.S. EPA is examining permitting use of the shoulder-carried imager as an alternate work practice for mandatory monitoring of refinery piping and valves. The petroleum industry sees gas imaging as a time- and cost-efficient alternative. The imager (which resembles a large camcorder) works using the backscatter absorption gas imager (BAGI) method, in which a scene suspected of containing a leak is illuminated with infrared laser light. The laser light is reflected by the background of the scene and absorbed by the leaking gas. A camera in the device gives a visual display of the scene with the plume appearing as a darker region. This news item carries brief information about the field trials.

http://www.sandia.gov/LabNews/LN11-28-03/key11-28-03_stories.html#plume

Geophysical Imaging of Stimulated Microbial Biomineralization

Williams, K.H. (Univ. of California, Berkeley); D. Ntarlagiannis and L.D. Slater (Rutgers

Univ.); A. Dohnalkova (PNNL); S.S. Hubbard and J.F. Banfield (LBNL).

Environmental Science & Technology, Vol 39 No 19, p 7592-7600, 2005

Noninvasive geophysical methods were used to monitor biomineralization at the laboratory scale during stimulated sulfate reduction under dynamic flow conditions. Alterations in sediment characteristics resulting from microbe-mediated sulfide mineral precipitation reflected changes in complex resistivity and acoustic wave propagation signatures. The sequestration of zinc and iron in insoluble sulfides led to alterations in the ability of the pore fluid to conduct electrical charge and of the saturated sediments to dissipate acoustic energy. These changes resulted directly from the nucleation, growth, and development of nanoparticulate precipitates along grain surfaces and within the pore space. Scanning and transmission electron microscopy confirmed the sulfides to be associated with cell surfaces, with precipitates ranging from aggregates of individual 3- to 5-nm nanocrystals to larger assemblages of up to 10 to 20 μm in diameter. These results suggest the potential for using geophysical techniques to image certain subsurface biogeochemical processes, such as those accompanying the bioremediation of metal-contaminated aquifers.

<http://www.andromeda.rutgers.edu/~geology/Faculty/Slater/Williams%20et%20al..pdf>

Groundwater Sampling Tool

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 36 pp, Sep 2005

The purpose of this tool is to help Remedial Project Managers (RPMs) ensure that proper groundwater sampling protocols are followed by their contractors in the field. The use of incorrect field procedures may adversely affect data quality and impact the ability of RPMs to make sound decisions for site cleanup. RPMs should include specific sampling procedures in the statement of work for each project and should have the ability to audit contractors in the field.

The following topics are covered in this tool to assist RPMs with contractor oversight: (1) Pre-field sampling activities, (2) Procedures for low-flow, high purge, and passive diffusion bag (PDB) sampling, (3) Quality Assurance/Quality Control (QA/QC) measures, (4) Field audit, including a customized audit form that may be created and printed out from the field audit section of this tool, and (5) Data management.

<http://www.ert2.org/ert2portal/DesktopDefault.aspx>

A Guide for Local Authorities Purchasing Air Quality Monitoring Equipment
Mooney, Diane.

Department for Environment, Food and Rural Affairs, the Scottish Executive, the Welsh Assembly Government and the Department of the Environment in Northern Ireland. Report No: AEAT/ENV/R/2088 Issue 1, 15 pp, Jan 2006

This document was written to provide a simple guide and checklist for authorities wishing to purchase and operate automatic air pollution monitoring equipment for detailed monitoring. The following questions should be considered before proceeding with any air quality monitoring project. (1) What pollutants need to be monitored? (2) What monitoring methods are appropriate? (3) What else is needed for the installation? (4) What level of QA/QC is required? (5) Where is it practical to locate the equipment? (6) How long to monitor for? (7) Will "accredited" calibrations help? (8) How much will all this cost to purchase, to operate, and to maintain? It is intended to be read in conjunction with Defra's Technical Guidance for Review and Assessment (LAQM TG (03)), The AURN Site Operator's Manual at <http://www.aeat.co.uk/netcen/airqual/reports/loman/loman.html>, and The Frequently Asked Questions (FAQs) on the LAQM Helpline page of the Air Quality Archive at <http://www.airquality.co.uk/archive/laqm/helpline.php>
http://www.airquality.co.uk/archive/reports/reports.php?action=category§ion_id=6

Guide for the Assessment of the Vapor Intrusion Pathway

Cox, D.N. (Mitretek Systems, Inc., Greenwood Village, CO); W.B. Howard; M.A. Smith.
Report No: IOH-RS-BR-SR-2006-0001, NTIS: ADA449121, 64 pp, Feb 2006

This document has been developed by the Health Risk Assessment Branch of the Air Force Institute for Operational Health as an informational resource for Air Force environmental managers who are interested in evaluating the vapor intrusion pathway. This pathway has received substantial scrutiny in recent years by U.S. EPA and state environmental regulatory agencies. The potential health risks from vapor intrusion are being evaluated at numerous sites across the country. Volatilization and migration of chemicals from contaminated ground water and subsurface soil can leak through cracks and holes in buildings located above the contamination. These cracks provide a pathway that can result in undesirable levels of human exposure. EPA has developed a detailed vapor intrusion guide that uses a tiered approach to evaluate the potential risks associated with this pathway. This Air Force-specific document generally follows and supports the modeling and risk assessment approaches recommended by EPA. The primary focus of this document is to provide a discussion of various approaches, problems, and solutions related to assessing and managing the vapor intrusion pathway. This guidance covers indoor air quality, air sampling and analysis, analytical methods, risk assessment, remediation, and risk management.

<http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=ADA449121&Location=U2&doc=GetTRDoc.pdf>

Hand-Held Unit for Simultaneous Detection of Methane and Ethane Based on NIR-Absorption Spectroscopy

Hennig O.; Strzoda R.; Magori E.; Chemisky E.; Tump C.; Fleischer M.; Meixner H.; Eisele I. SIEMENS AG Corporate Technology, Munich, Germany

Sensors and Actuators B: Chemical, Vol 95 Nos 1-3, p 151-156, 15 October 2003

This paper reports the development of a hand-held and low-power sensor, based on direct absorption spectroscopy for leak detection (methane), natural gas identification, and lower-explosion-limit measurements (methane and ethane). A tunable DFB laser diode is used to acquire and determine simultaneously the characteristic NIR-absorption lines of methane and ethane and their concentrations. The algorithm corrects for ambient temperature and pressure. The battery operation lifetime under normal conditions and constant operation is 8+ hours.

HCHO Detection by High-Resolution Laser DOAS

Schlosser, E., J. Bossmeyer, T. Brauers, H.-P. Dorn, and R. Tillmann, ICG II, Forschungszentrum Jülich, Germany.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

Measurements of formaldehyde (HCHO) are needed for most experiments at the Jülich SAPHIR atmosphere simulation chamber. The measurements are taken with a calibrated fluorescence detector based on the Hantzsch reaction. A low-resolution LP-DOAS setup using a broadband Xenon short arc lamp has also been installed at the chamber parallel to the existing high-resolution LP-DOAS instrument. The laser-DOAS uses a UV/laser light source and a White cell and has been optimized to detect hydroxyl radicals at 308 nm. The instrument detects HCHO and a few other trace gases (SO₂, naphthalene) simultaneously during standard operation. The instrument has a linear dispersion of 0.24 pm:pixel⁻¹ and a spectral resolution of 112,000 which corresponds to a resolution limit of 2.7 pm (0.28 cm⁻¹). The HCHO absorption cross section within the spectral region chosen for the OH detection is small (< 1:10-20 cm²) to minimize interferences. The measured differential absorption spectra are compared with those presently available. The high-resolution differential HCHO reference spectrum used for the laser-DOAS evaluation cannot be derived from independent measurements of the absorption cross section near 308 nm because no sufficiently high resolved spectra were available until recently. New work on absolute HCHO measurements near 308 nm has been reported that uses a scanned dye laser with an emission bandwidth of 0.1 to 0.15 cm⁻¹. The spectral resolution would be suitable for preparing useful differential spectra for the laser-DOAS instrument; however, it appears that the spectra published do not reproduce the rovibrational structure observed by the laser-DOAS instrument, hence the laser-DOAS measurement continues to be dependent on the calibration of the HCHO monitor. Chamber measurements of HCHO taken with the high-resolution laser-DOAS measurements are compared to other simultaneous measurements of the broadband-DOAS and the Hantzsch HCHO monitor.

High-Energy Multipass Forward Raman Shifter as an Eye-Safe Laser Source for Lidar

Spuler, Scott M. and Shane D. Mayor, National Center for Atmospheric Research, Boulder, CO. 23rd International Laser Radar Conference, 24-28 July 2006, Nara, Japan

A methane Raman cell optimized for generating high energy laser pulses at 1.54 microns wavelength is characterized. First Stokes conversion efficiencies up to 43% -- equivalent to 62%

photon conversion efficiency -- were measured. Output average power is observed in excess of 17.5 W, pulse energies of 350 mJ at 50Hz, with good beam quality ($M2 < 6.$) Narrow bandwidth output is produced when pumping with a single longitudinal mode Nd:YAG laser and seeding the Stokes process with a narrowband laser diode.

http://www.eol.ucar.edu/lidar/real/Spuler_Mayor_2006ILRC_Rev.pdf

High Resolution In-Situ Monitoring of Hyporheic Zone Biogeochemistry
Bridge, J.W.

Environment Agency, UK. Science Report SC030155/SR3, ISBN:1-84432-424-9, 51 pp, 2005

The hyporheic zone is the part of a streambed through which a mixture of surface water and ground water flows. Existing hyporheic zone research methods are largely based around physical sampling and removal for ex situ analysis. Attempts to conduct in situ measurements have concentrated on the use of chambers that provide some degree of environmental control to improve measurement reliability. True in situ measurement devices range from standard temperature, pH, and redox probes to electrochemical probes, such as ion-selective and gel-integrated microelectrodes (GIMEs), and reactive surface probes, such as diffusive gradient in thin film (DGT), diffusive equilibration in thin film (DET), and semi-permeable membrane device (SPMD) probes. These can provide direct measurement of a wide variety of chemical species of interest, including sulfides; metals; trace elements; polychlorinated, organochlorine, and polycyclic aromatic hydrocarbons; and a wide range of common nutrient ions. Biosensors are tools of widely increasing use for environmental monitoring. They have the advantage of being able to distinguish bioavailable chemical species from total or active concentrations. Significant technological developments in genetic modification and biomolecular science in recent years mean that the range of targets for biosensors is increasingly broad and includes many organic pollutants, pathogens, heavy metals, and standard measures, such as biological oxygen demand and temperature. Other techniques, including optodes, fibreoptics, and geophysical methods, are discussed.

<http://publications.environment-agency.gov.uk/pdf/SCHO0605BJCO-e-e.pdf>

Hydrazine Leak Detection Using Poly (3-Hexylthiophene) Thin Film Micro-Sensor

Yang, H., J. Wan, H. Shu, X. Liu, R.S. Lakshmanan, R. Guntupalli, J. Hu, W. Howard, and B.A. Chin.

Sensors for Propulsion Measurement Applications. Proceedings of SPIE--The International Society for Optical Engineering, Vol 6222, May 2006

Hydrazine, a highly toxic compound, is mostly used as a propellant in the control/propulsion system of missiles, spacecraft, and satellites. A low-cost, passive, and highly sensitive microsensor has been developed for real-time monitoring for the accidental release of hydrazine. The microsensor, composed of interdigitated electrodes and a hydrazine-sensitive poly(3-hexylthiophene) (P3HT) thin film, is fabricated using standard microelectronic manufacturing techniques. When exposed to 1 ppm hydrazine gas, the compensation interaction between the reducing hydrazine gas and p-type doped P3HT leads to a five orders of magnitude increase in the resistance of the device. The sensor is capable of detecting hydrazine leaks from tens of ppb to tens of ppm concentration. The sensitivity of sensor increases with the increasing of hydrazine concentration and the decreasing of the polymer film thickness.

Hyperspectral Image Assessment of Oil-Contaminated Wetland

Salem, F. and M. Kafatos (George Mason Univ., Fairfax, VA); T. El-Ghazawi (George Washington Univ., Washington, DC); R. Gomez and R. Yang (George Mason Univ.).
International Journal of Remote Sensing, Vol 26 No 4, p 811-821, 20 Feb 2005

A created prototype demonstrates how hyperspectral data can supplement information on environmental deterioration due to oil pollution, specifically the Patuxent River wetland at the Chesapeake Bay in Maryland. The data allow an assessment of the current state of wetland losses and habitat changes due to oil pollution of local waters and associated wetlands. Airborne Imaging Spectro-Radiometer for Applications (AISA) hyperspectral imagery was used for this study, and the results were derived using the Environment for Visualizing Images (ENVI) software. The use of different classifiers showed low accuracy and class overlap for many classes, so a ground data image was created using maximum likelihood classification to compare the results of several classifiers and to assess the accuracy of each technique. Using 2D scatter plots for selecting regions of interest yielded more accurate results than digitizing polygons for training samples, allowing precise identification of stressed vegetation and soil damaged by polluted water.

http://scs.gmu.edu/~rgomez/oilspill_pub_paper.pdf

Hyperspectral Remote Sensing of Chemical & Biological Agents

Lewis, A.J., M.Z. Salvador, and R.B. Gomez, George Mason Univ., Fairfax, VA.
2nd Joint Conference on Point Detection, Williamsburg, Virginia, March 2004. 14 pp.

Hyperspectral imaging (HSI) is a powerful tool for the detection of chemical and biological (CB) agents. HSI provides the capability to discriminate, classify, and identify materials present in the image based on their spectral characteristics. To be effective as a CB detection tool, HSI sensors and analysis software must provide near real-time performance and function in a mostly automated fashion. This paper presents an overview of ongoing research that addresses some of the areas where improvement is required before HSI can be effectively utilized for the detection of CB agents. Several algorithms are helping to increase performance. Wavelet Transformations and the Spectral Similarity Value techniques are discussed. High-performance computing techniques can also be utilized to increase system performance to desired levels. The costs and benefits of clusters and computational grids for HSI CB detection are compared. The use of visualization techniques suitable for an operational HSI CB system is discussed, including advanced spectral library searching techniques and information displays for non-spectral expert operators.

<http://scs.gmu.edu/~rgomez/Chem%20&%20Bio%20HSI%20FINAL.doc>

Identification of Trace Metal Speciation in Environment Using Z-Contrast Imaging

Utsunomiya, S., Univ. of Michigan, Ann Arbor.

15th V.M. Goldschmidt Conference, 20 - 25 May 2005, Moscow, Idaho.

To characterize trace metals in various environmental and geological samples, researchers utilized high-angle annular dark-field screening transmission electron microscopy (HAADF-STEM) combined with conventional TEM techniques. The image contrast observed in the HAADF-STEM is correlated to the atomic mass; heavier elements contribute to a brighter

contrast. Image contrast also is characteristically independent of focus, because the image is formed by incoherent scattering. Results obtained using the advanced TEM technique are provided. The following work with this technology is discussed: (1) investigation of metal concentrations and speciation in fine- and ultra-fine particles with heavy metals in urban aerosols from various locations and (2) direct, near atomic-scale characterization of Pb zircon. These examples illustrate the value of HAADF-STEM as a powerful technique for the direct investigation and identification of trace elements in nanoscale particles that is particularly useful for the relatively heavy metals that occur at extremely low bulk concentrations (ppb to ppm) in a lighter element matrix.

Imaging Remote Sensing Fourier Transform Spectrometer with a Focal Plane Array Detector: First Measurements

Harig, Roland and Jörn-Hinrich Gerhard, TU Hamburg-Harburg, Hamburg, Germany.
VDI-Berichte 1885, ISBN: 3-18-091885-3, p 261-265, 2005

Passive remote sensing by infrared spectrometry allows detection and identification of hazardous clouds from long distances. Typical applications of the method are automatic surveillance of industrial facilities and identification of hazardous clouds after chemical accidents. A conventional remote sensing Fourier transform infrared spectrometer is based on an interferometer with a single detector element. The output of the system is usually a yes/no decision by an automatic identification algorithm that analyses the measured spectrum. The analysis of the measured spectrum by the operator is complicated and thus this task requires an expert. Even if a scanning system is used for surveillance of a large area, the operator is dependent on the decision of the algorithm. In contrast to that, imaging systems allow automatic identification but also simple interpretation of the result, i.e., the image of the cloud. An imaging spectrometer with these capabilities is the scanning infrared gas imaging system (SIGIS). The system is based on an interferometer with a single detector element in combination with a telescope and a synchronized scanning mirror. The results of the analyses of the spectra are displayed by an overlay of a false-color image--the "hazardous chemical image"--on a video image. The temporal resolution of the system is limited by the sequential measurement of all fields of view within the field of view. To measure a complete image by a single scan of the interferometer, an imaging Fourier-transform spectrometer (IFTS) with a detector array instead of a single detector element is currently being developed. The first measurements are presented. http://www.et1.tu-harburg.de/ftir/lib/Harig_Imaging_FTIR.pdf

Immobilization of a Catalytic DNA Molecular Beacon on Au for Pb(II) Detection

Swearingen, C.B., D.P. Wernette, D.M. Cropek, Y. Lu, J.V. Sweedler, and P.W. Bohn.
Analytical Chemistry, Vol 77, p 442-448, 2005

A Pb(II)-specific DNAzyme fluorescent sensor was modified with a thiol moiety to immobilize it on an Au surface. Self-assembly of the DNAzyme was accomplished by first adsorbing the single-thiolated enzyme strand (HS-17E-Dy) followed by adsorption of mercaptohexanol, which serves to displace any Au-N interactions and ensure that DNA is bound only through the S-headgroup. The preformed self-assembled monolayer is then hybridized with the complementary fluorophore-containing substrate strand, 17DS-F1. Upon reaction with Pb(II), the substrate strand is cleaved, releasing a fluorescent fragment for detection. Fluorescence

intensity may be correlated with original Pb(II) concentration. The immobilized DNAzyme can be regenerated after cleavage, allowing multiple sensing cycles. Immobilization of the DNAzyme sensor onto a Au surface lowers the detection limit (from 10 to 1 nM), maintains activity and specificity, and allows sensor regeneration and long-term storage.

<http://montypython.scs.uiuc.edu/paper.htm>

Implementation Guide for Assessing and Managing Contaminated Sediment at Navy Facilities, Revision 2

SPAWAR Systems Center San Diego.

Naval Facilities Engineering Command (NFESC) User's Guide UG-2053-ENV, 294 pp, Jan 2005

This document presents guidelines for conducting sediment site assessments and remedial alternative evaluations within the Navy's Environmental Restoration program. It is intended for use by Remedial Project Managers (RPMs) and their technical support staff as stepwise guidance that will apply to most Navy sediment investigations. Sediment investigations often are more complex than terrestrial investigations for a variety of reasons, including a lack of promulgated sediment quality criteria, incomplete knowledge and understanding of aquatic food webs, and lack of published risk-based threshold data (e.g., toxicity reference values) for many chemicals of potential concern. Additionally, sediments commonly require specialized methods for sampling, analysis, and remediation. This guide identifies and discusses sediment-specific issues related to site characterization, risk assessment, and remedial alternative evaluation, and then directs the reader to related Web sites and resources for more detailed technical information. It is intended to help the RPM avoid unfocused or unnecessary studies and to coordinate and integrate data collection activities across all aspects of the sediment investigation. Critical sediment issues discussed in this guide include the following: (1) Addressing multiple contaminant sources (Navy and non-Navy); (2) Development of a detailed and accurate Conceptual Site Model (CSM); (3) Collection of important geochemical and physical information for characterizing the source, fate, and transport of chemicals in sediment and supporting the evaluation of remedial alternatives; (4) Selection and use of appropriate tests for ecological risk assessments (ERAs) (e.g., bioavailability evaluations, aquatic toxicity tests); (5) Use of background and reference site data in risk assessments; (6) Use of a weight-of-evidence (WOE) approach and other decision-making tools; (7) Development of site-specific risk-based cleanup goals; and (8) Evaluating remedial options for sediment and the risk and liabilities associated with each.

http://enviro.nfesc.navy.mil/erb/erb_a/restoration/fcs_area/con_sed/ug-2053/ug-2053-sed-rev-2.pdf

Improved Method "Grid Translation" for Mapping Environmental Pollutants Using a Two-Dimensional CAT Scanning System

Verkruysse, Wim and Lori A. Todd, Univ. of North Carolina at Chapel Hill.

Atmospheric Environment, Vol 38 No 12, p 1801-1809, Apr 2004

A method has been developed that improves 2-D tomographic mapping of air pollutants. In traditional reconstruction techniques, a single grid of cells was used to reconstruct a 2-D map from measured, line-integrated, open-path Fourier transform infrared (OP-FTIR) spectrometer measurements. Typically, in environmental 2-D imaging, the area of interest is sparsely sampled

with rays, which means the reconstruction grid resolution has to be coarse to avoid grid cells that are hit by very few rays. Successful reconstruction of a peak on a coarse grid depends on its position with respect to a grid cell. The authors present a recently developed "grid translation" method that allows the choice of the reconstruction resolution to be less critical than using previous single-grid methods and also improves the quantitative and qualitative reconstruction accuracy of concentration maps under the configuration constraints of OP-FTIR CAT scanning systems.

Improvement of the Detection Limit of Active DOAS-Measurements by Use of Fibre Light Source

Merten, Andre and Ulrich Platt, Heidelberg Univ., Heidelberg, Germany.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

In active DOAS-measurements, the minimum detectable optical density and thus the detection limit for trace gases are primarily determined by the spectral stability of the light source, such as a Xenon high-pressure lamp. This is particularly important in spectral ranges where Xe-lines exist. Due to the large temperature gradient and turbulent flow inside the arc these spectral structures strongly vary with time and across the arc of the Xe-high pressure lamp. The use of fibre coupled Xe-light source together with a mathematical treatment reduces the residual structures up to a magnitude. With this new optical setup, it is possible to design new types of long-path devices, which are easier to handle and show a larger flux of light.

In-Situ Measurements of CH₄ in the Ambient Air of Arico's Landfill, Tenerife, Canary Islands, by Means of OP-FTIR Spectroscopy

Lima, N. and D. Nolasco (Inst. of Technology and Renewable Energy (ITRE), Spain); S. Briz (Univ. Europea de Madrid, Spain); P. Hernandez and N. Perez (ITRE, Spain).

Remote Sensing: 11th SPIE International Symposium, 13-16 September 2004, Maspalomas, Gran Canaria, Canary Islands, Spain. Final Programme/Abstract Book, p 55, 2004

Several surveys of methane (CH₄) in the ambient air of Arico's landfill were performed with an OP-FTIR spectrometer MIDAC 2401-C and an external IR source during 2002 and 2003. The spectrometer is equipped with an InSb detector and CaF₂ optics, which supplies a spectral range from 10,000 to 1,500 cm⁻¹. The results from the 2002 and 2003 surveys are discussed. The observations showed that the highest landfill air CH₄ concentrations occur in the central area of the landfill, where the highest non-controlled CH₄ emissions have also been observed by means of the accumulation chamber method.

Incorporation of a DNAzyme into Au-Coated Nanocapillary Array Membranes with an Internal Standard for Pb(II) Sensing

Wernette, D.P., C.B. Swearingen, D.M. Crokek, Y. Lu, J.V. Sweeler, and P.W. Bohn
Analyst, Vol 131, p 41-47, 1 June 2006

A Pb(II)-specific DNAzyme has been incorporated into Au-coated polycarbonate track-etched (PCTE) nanocapillary array membranes (NCAMs) by thiol/gold immobilization, providing a substrate-bound sensor that uses a novel internal control methodology for fluorescence-based detection of Pb(II). The Pb(II)-sensing structure can be stored in a prepared

state for 30 days and regenerated after reaction, with detection of Pb(II) concentrations as low as 17 nM (3.5 ppb).

<http://montypython.scs.uiuc.edu/paper.htm>

Induced-Polarization Measurements on Unconsolidated Sediments from a Site of Active Hydrocarbon Biodegradation

Abdel Aal, Gamal Z. (Univ. of Missouri-Rolla); Lee D. Slater (Rutgers Univ., Newark, NJ); Estella A. Atekwana (Univ. of Missouri-Rolla).

Geophysics, Vol 71 No 2, p H13-H24, Mar/Apr 2006

To investigate the potential role that indigenous microorganisms and microbial processes may play in altering low-frequency electrical properties, induced-polarization (IP) measurements in the frequency range of 0.1 to 1000 Hz were acquired from sediment samples taken from a hydrocarbon-contaminated site showing evidence of intrinsic contaminant biodegradation. In samples from the smear zone, which was contaminated with dissolved-phase hydrocarbons, increased imaginary conductivity and phase were observed that exceeded values obtained for samples. Real conductivity, though generally elevated, did not show a strong correlation with contamination. Controlled experiments on uncontaminated samples from the field site indicate that variations in surface area, electrolytic conductivity, and water content across the site cannot account for the high imaginary conductivity observed within the smear zone. The authors suggest that microbial processes may be responsible for the enhanced IP response observed at contaminated locations, i.e., that the accumulation of biofilms at the mineral/electrolyte interface generates the IP response. These findings indicate the potential use of electrical measurements to monitor microbial activity noninvasively at sites undergoing intrinsic biodegradation of hydrocarbons.

<http://www.andromeda.rutgers.edu/~geology/Faculty/Slater/Abdel%20Aal%20et%20al%202006%20.pdf>

Influence of the Elemental Composition and Concentration of Surfactants on the Atomic Absorption of Chromium

Yurchenko, O.I., A.A. Shkumat, and N.P. Titova, V. N. Karazin Kharkov National Univ., Kharkov, Ukraine.

Journal of Applied Spectroscopy, Vol 72 No 4, p 546-550, July 2005

Systematic investigations of the influence of the elemental composition and concentration of surfactants on the atomic absorption of chromium have shown that sodium dodecyl sulfate maximally increases the analytical signal and selectivity in chromium determination. The authors describe the atomic-absorption technique of determining the quantitative content of chromium in sewage of industrial enterprises, with application of sodium dodecyl sulfate as a chemical modifier. The detection limit for chromium is 1.2 ug/dm³.

An Internal Reference Technique for Accurately Quantifying Specific mRNAs by Real-Time PCR with Application to the *tceA* Reductive Dehalogenase Gene

Johnson, D.R., P.K.H. Lee, V.F. Holmes, and L. Alvarez-Cohen, Univ. of California, Berkeley. Applied and Environmental Microbiology, July 2005, p. 3866-3871, Vol. 71, No. 7

The accuracy of mRNA quantification by reverse transcription (RT) in conjunction with real-time PCR (qPCR) is limited by mRNA losses during sample preparation (cell lysis, RNA isolation, and DNA removal) and by inefficiencies in reverse transcription. A technique that utilizes an exogenous internal reference mRNA (ref mRNA) along with mRNA absolute standard curves was applied to quantify mRNA of the trichloroethene (TCE) reductive dehalogenase-encoding *tceA* gene in an anaerobic TCE-to-ethene dechlorinating microbial enrichment. Application of the new technique increased measured quantities of *tceA* mRNA by threefold. The technique was also effective for quantifying the loss of mRNA during specific steps of the sample-processing protocol. When the technique was applied to compare the effects of cellular exposure to different chlorinated ethenes on *tceA* expression, exposure to TCE or cis-1,2-dichloroethene resulted in 25-fold-higher quantities of *tceA* mRNA than exposure to vinyl chloride or chlorinated ethene starvation.

<http://aem.asm.org/cgi/content/full/71/7/3866>

Inversion of Tracer Test Data Using Tomographic Constraints

Linde, N. (CNRS, Univ. Paul Cezanne, Aix-en-Provence, France); S. Finsterle and S. Hubbard (LBNL, Berkeley, CA).

Water Resources Research, Vol 42, 2006

The authors have developed a methodology for inverting tracer test data using zonation information obtained from 2-D radar tomograms to improve the (typically overly smooth) hydraulic conductivity fields obtained from conventional inversion of tracer test data. The method simultaneously yields 2-D estimates of hydraulic conductivity, as well as petrophysical relationships that relate hydraulic conductivity to radar velocity; these relationships can be assumed to be stationary throughout the area of investigation or to vary as a function of zonation. Using a synthetic 3-D hydraulic conductivity field, the developed inversion methodology is applied to explore the impact of the strength and stationarity of the petrophysical relationship, as well as the impact of errors that are often associated with radar data acquisition (such as unknown borehole deviation). Adding radar tomographic data to tracer test data improves hydrogeological site characterization, even in the presence of minor radar data errors. The results are contingent on the assumption that a relationship between radar velocity and hydraulic conductivity exists. Therefore the applicability of the proposed method may be limited to field sites where this condition is partially or fully satisfied.

http://esd.lbl.gov/sshubbard/wrr_42_2006a.pdf

Investigation of Extraction and Clean-Up Procedures Used in the Quantification and Stable Isotopic Characterisation of PAHs in Contaminated Urban Soils

Graham, M.C. (Univ. of Edinburgh, UK); R. Allan; A.E. Fallick; J.G. Farmer.

Science of the Total Environment, Vol 360 No 1-3, p 81-89, 1 May 2006

Four different extraction methods--soxhlet, soxtherm, sonication, and accelerated solvent extraction--were used to isolate the 16 priority pollutant PAHs from a certified reference soil and

from a contaminated soil. Though all methods were found to give accurate and highly reproducible concentration data, significant between-method and sometimes within-method variability was observed in the stable carbon isotope signatures obtained for individual PAHs in the contaminated soil using GC-C-IRMS. When two cleanup procedures, silica/dichloromethane and alumina/hexane/toluene, were used to remove co-extracted material, accelerated solvent extraction gave the more consistent and reproducible stable carbon isotope data.

It Whistles: Change in Pitch Tells All in New Sonic Gas Analyzer

Penn State Live, 25 Oct 2005

Penn State researchers have developed a prototype sonic gas analyzer that automatically and continuously tracks the concentration of a gas in an air/gas mixture based on changes in pitch. "The system automatically cancels out the background and flow noise and can detect changes in gas concentration as low as 0.003 percent -- plenty sensitive enough, for example, to let you know if you've got an explosive mixture," said Miguel Horta, a doctoral candidate in acoustics who currently is working on the sonic gas analyzer as part of his dissertation. The Penn State researchers are developing the current prototype to track continuously the concentrations of hydrogen produced by bacteria in microbial fuel cells (MFC). In MFCs, bacteria feed on the organic matter in wastewater and produce hydrogen for use as fuel while simultaneously cleaning the water. The new system also could be adapted for tracking toxic or flammable gases in mines, sewers, or landfills; detecting hydrogen in battery compartments of boats and electric cars; or monitoring in industries where gases are consumed as feedstocks. In the Penn State sonic gas analyzer, a miniature speaker produces a tone that sounds like a whistle and is barely audible outside the resonator. Two tiny microphones capture the tone, called a resonance frequency, and the two-microphone outputs then are subtracted to double the signal of interest and cancel any extraneous noise before being fed to an electronic tracking system, called a phase-locked loop. This tracking system determines the changes in the resonance frequency caused by the changes in gas concentration, while simultaneously correcting for any changes in the gas temperature. A change in the concentration of a gas in the gas/air mixture passing through the system changes the resonance frequency. The change in pitch tells what the change in gas concentration is at every instant without disturbing the system or requiring extraction of gas samples. Because the sonic gas analyzer only introduces sound, it doesn't change the temperature of the gas mixture, as do thermal conductivity analyzers. Measurements on helium, sulfur hexafluoride, and hydrogen show an immediate response by the analyzer to the introduction of a contaminating gas. The necessary time for the gases to become thoroughly mixed within the system varies from approximately 30 seconds for lighter gases such as helium and hydrogen to about one minute for the heavier sulfur hexafluoride. Once the gases are mixed, the resonance frequency is stable to about 0.02 Hz, corresponding to a concentration resolution on the order of 30 ppm.

<http://live.psu.edu/story/14159>

Joint Application of Doppler Lidar and Differential Absorption Lidar to Estimate the Atomic Mercury Flux from a Chlor-Alkali Plant

Bennett, M., H. Edner, R. Gronlund, M. Sjöholm, S. Svanberg, and R. Ferrara.

Atmospheric Environment, Vol 40 No 4, p 664-673, Feb 2006

Differential absorption lidar (DIAL) measurements of mercury concentrations downwind of a chlor-alkali plant were combined with measurements of wind profiles made with a Doppler Lidar based on modern fiber-optic technology, allowing a more precise estimate of the fugitive emission of mercury from the plant than could be obtained by using anemometer measurements of the wind. The emission rate varies strongly with the meteorological conditions. Where a precise estimate of a steady flux is required, reliable measurements of the wind profile in the wake of the source are essential. Doppler Lidar provides a possible method for acquiring such measurements.

Joint Inversion of Geophysical and Hydrological Data for Improved Subsurface Characterization

Kowalsky, M.B., J. Chen, and S.S. Hubbard, Lawrence Berkeley National Lab, CA.

The Leading Edge, Vol 25 No 6, p 730-734, June 2006

Understanding fluid distribution and movement in the subsurface is critical for a variety of subsurface applications, such as remediation of environmental contaminants, sequestration of nuclear waste and CO₂, intrusion of saline water into fresh water aquifers, and the production of oil and gas. It is well recognized that characterizing the properties that control fluids in the subsurface with the accuracy and spatial coverage needed to parameterize flow and transport models is challenging using conventional borehole data alone. Integration of conventional borehole data with more spatially extensive geophysical data (obtained from the surface, between boreholes, and from surface to boreholes) shows promise for providing quantitative information about subsurface properties and processes. Typically, estimation of subsurface properties involves a two-step procedure in which geophysical data are first inverted and then integrated with direct measurements and petrophysical relationship information to estimate hydrological parameters; however, errors inherent to geophysical data acquisition and inversion approaches and errors associated with petrophysical relationships can decrease the value of geophysical data in the estimation procedure. In this paper, the authors using two examples to illustrate how joint inversion approaches, or simultaneous inversion of geophysical and hydrological data, offer great potential for overcoming some of these limitations.

http://esd.lbl.gov/sshubbard/tle_kowalsky_2006.pdf

Joint Workshop on Long-Term Monitoring of Metals and Radionuclides in the Subsurface: Strategies, Tools and Case Studies. Workshop Summary Report

Florida State Univ., 57 pp, Apr 2004

On April 21-22, 2004, a workshop co-sponsored by DOE, Florida State University's Center for Integrated Sensor Technology and Environmental Monitoring Systems, and the U.S. Geological Survey was conducted at the USGS facility located in Reston, VA. The purpose of workshop was to bring together agencies that share a common environmental problem to identify areas of joint interest and research. Participants included representatives from state and federal agencies, national laboratories, universities, and other organizations. Evolving remediation technologies that address sites contaminated with metals and radionuclides, such as monitored

natural attenuation, enhanced passive remediation, stabilization/solidification or containment, require an ongoing and long-term monitoring (LTM) component to verify the performance of the remedial system. Similarly, most large-scale closure activities will leave behind residual contamination in the subsurface that will result in regulatory requirements for LTM. The goal of the workshop was to identify monitoring technologies that are currently being used to monitor metals and radionuclides in the subsurface and technologies that may be available or adaptable to specific needs. Two breakout sessions were held following the plenary session. The first focused on monitoring tools and techniques; the second focused on LTM strategies. This report identifies the key findings.

<http://www.cistems.fsu.edu/reports/report1.pdf>

Lab Study Pinpoints Nitrate Sources in Tri-Valley Groundwater

Lawrence Livermore National Laboratory News Release NR-06-06-06, 21 June 2006

Using a method of combining chemical and isotopic tracers, a team of scientists from Lawrence Livermore National Laboratory (LLNL) has completed a study that helps pinpoint the sources of nitrate in the Tri-Valley's groundwater supply. The study took place on a portion of the Valley's groundwater basin, which is managed by California's Zone 7 Water Agency. The study is part of the Groundwater Ambient Monitoring and Assessment (GAMA) project, a partnership between LLNL, the U.S. Geological Survey, and the State of California to study groundwater contamination throughout the state. About 10% of active California public water-supply wells have nitrate contamination exceeding the drinking water standard of 45 parts per million. In agricultural areas, such as Stanislaus County, up to 80% of groundwater is affected or polluted by nitrate. The study determined that contamination due to animal waste (including seepage from septic systems) has decreased over the past two decades, and that synthetic fertilizer is increasing as a source of nitrate contamination in the Valley's groundwater. The study also concluded that naturally occurring nitrogen in soil is the most likely source of high background levels of nitrate in basin groundwater. Nitrate contamination can come from application of synthetic fertilizer, confined animal operations, septic system discharge, or oxidation of soil nitrogen. To determine contamination sources, the researchers combined nitrate isotope data with other isotopic tracers such as tritium and the isotopic composition of water to provide insight into the routes and timing of nitrate in the groundwater. Stable isotopes provide information about water sources, while tritium-age dating defines groundwater residence times and transport behavior. In addition, dissolved gas and nitrate isotope evidence indicates that nitrate moves conservatively in the basin's groundwater, which simplifies source attribution. Based on these data, the team could determine whether the nitrate came from a waste water source (such as manure or septic system discharge) or a synthetic source (such as inorganic fertilizer). The study makes no recommendations, yet its findings will be used as the state and other water agencies determine future courses of action. The same group of LLNL scientists will carry out a detailed study of discharge from septic systems in Livermore in summer 2006, in cooperation with Zone 7 and the State of California.

http://www.llnl.gov/pao/news/news_releases/2006/NR-06-06-06.html

LIDAR: a Significant Tool for Regional 3D Air Pollutants and PBL Dynamics Measurements: Synthesis of a Series of Field Results Obtained on the Last Decade

Balin, I., G. Larcheveque, and P. Quaglia (EnviroScopY SA, PSE-EPFL, Lausanne, Switzerland), R. Nessler, B. Lazzarotto, P. Ristori, F. Jeanneret, V. Simeonov, B. Calpini, O. Couach, F. Kirchner, M. Parlange, and H. van den Bergh.
Geophysical Research Abstracts, Vol 8, No 10120, 2006

This paper discusses the significance of LIDAR air pollution measurements based on the synthesis of case applications from real field locations world-wide where representative 3D atmospheric parameters have been measured during the last decade. Noteworthy results from operation of various lidar setups--PBL/aerosols elastic backscatter, O₃ DIAL, H₂O Raman, OH Pump/Probe--are illustrated. LIDAR has a considerable role to play as a complementary 3D tool in the assessment of regional air pollution in areas such as photochemical ozone, OH radical, aerosols load, and planetary boundary layers.

Long Path DOAS Tomography by the Use of Multibeam DOAS Instruments: Results of an Indoor Validation Campaign

Mettendorf, K.U., A. Hartl, U. Platt, and I. Pundt, Univ. of Heidelberg, Germany.
Geophysical Research Abstracts, Vol 7, No 08543, 2005

Long-path DOAS (differential optical absorption spectroscopy) tomography uses 10 to 40 intersecting light beams to probe 2 to 3 dimensional concentration distributions of various trace gases (e.g., NO₂, SO₂, ozone, HCHO) in the measurement area. The concentration distributions can be reconstructed with suitable inversion algorithms from the average concentrations measured along the different light paths. To validate the method, recently developed multibeam long-path DOAS tomography instruments were applied indoors in an empty facility hall in Heidelberg, Germany. The results are provided of measurements of NO₂ from three multibeam instruments of 39 different light paths in a space 10 m x 15 m. The measurements were reconstructed using the simultaneous iterative reconstruction technique.

Long Path DOAS Tomography on a Motorway Exhaust Gas Plume: Numerical Studies and Application to Data from the BAB II Campaign

Laepfle, T., V. Knab, K.-U. Mettendorf, and I. Pundt, Univ. of Heidelberg, Heidelberg, Germany.

Atmospheric Chemistry and Physics, Vol 4, p 1323-1342, 2004

A procedure is presented for performing and optimizing inversions for DOAS tomography and its application to measurement data. Due to the limited amount of data measured, the resulting concentration fields are sensitive to the inversion process, and detailed error estimations are needed to determine the quality of the reconstruction. Different row acting methods are compared for the inversion. A procedure is presented for optimizing the parameters of the reconstruction process and a way to estimate the error-fields by numerical studies is proposed. The procedure was applied to data from the motorway emission campaign BAB II. Numerical studies from the motorway campaign show that DOAS tomography is able to produce high-quality concentration maps.

<http://www.atmos-chem-phys.net/4/1323/2004/acp-4-1323-2004.pdf>

Long Term Measurement of Trace Gases at GEOSummit Using Multi-Axis Differential Optical Absorption Spectroscopy

Bales R., J. Stutz, and S. Hurlock.

GEOSummit Meeting held January 2006.

[PowerPoint presentation, no abstract.]

<http://www.geosummit.org/resource/06mtg/stutz/>

A Look at Open-Path and Extractive Optical Gas Detection

Spellicy, Robert L.

EM, p 14-20, Nov 2003

Optical monitors that offer near-real-time detection and reporting of gaseous compounds have become the instruments of choice to perform multiple environmental and industrial monitoring tasks, largely due to their unique capabilities. This article provides an overview of the basic concepts of optical monitoring technology and serves as an introduction to the three articles that follow. The emphasis in this issue is particular applications of open-path and extractive monitoring. Newer optical instruments in use today include the Fourier transform infrared (FTIR) spectrometer, tunable diode laser (TDL) systems, differential optical absorption spectrometry (DOAS), and light detection and ranging (Lidar) systems.

<http://www.awma.org/em/pdfs/2003/11/spellicy.pdf>

Low-Cost Standoff Laser Sensing for Smart LDAR

Frish, M.B., Physical Sciences, Inc., Andover, MA.

AWMA 99th Annual Conference, 20-23 June 2006, New Orleans, Louisiana

The Remote Methane Leak Detector (RMLD) is a commercially available tool now in use for surveying natural gas leaks. The device is an eye-safe, laser-based natural gas sensor used to locate leaks in natural gas transmission and distribution pipelines. This device works much like a flashlight--shine the laser beam onto a surface, and the RMLD reports how much gas is between you and the surface. RMLD's remote or stand-off sensing capability allows the user to survey areas that may be difficult to reach, such as busy roadways, yards surrounded by fences or protected by dogs, pipes suspended under a bridge, indoor commercial piping, and other hard-to-access places. An audible alarm sounds when it detects a high concentration or quickly changing gas cloud that indicates a pipeline leak. The RMLD is based on the optical measurement technology known as tunable diode laser absorption spectroscopy (TDLAS). When the laser beam passes through natural gas, the methane in the gas absorbs a portion of the light, which the RMLD then detects. A Small Business Innovation Research (SBIR) grant from U.S. EPA initiated the RMLD project, and the funding enabled PSI to demonstrate the economic and technical feasibility of the concept.

<http://www.psicorp.com/publications/PDF/sr-1248.pdf>

Low Frequency Electrical Properties of Corroded Iron Barrier Cores

Wu, Yuxin and Lee D. Slater (Rutgers Univ., Newark, NJ); Nick Korte (Grand Junction, CO).

Environmental Science & Technology, Vol 40 No 7, p 2254-2261, 2006

Angle cores taken from a zero-valent iron permeable reactive barrier installation after 8 years of operation were examined for the electrical signatures of iron corrosion and mineral precipitation. The real and imaginary parts of the complex electrical conductivity measured between 0.1 and 1000 Hz were 2 to 10 times higher (varying between cores) in the reacted zone at the upgradient edge of the barrier relative to less altered locations inside the barrier. Scanning electron microscopy identified iron surface alteration with the thickest corrosion rinds closest to the upgradient soil/iron interface. Surface area of iron minerals was also greatest at the upgradient interface, gradually decreasing into the cores. X-ray diffractometry identified precipitation of iron oxide/hydroxide, carbonate minerals, iron sulfide, as well as green rusts, with mineral complexity decreasing away from the interface. The electrical measurements correlate well with the solid-phase analyses, indicating that electrical methods could be used to assess or monitor the occurrence of iron corrosion and mineral precipitation in PRBs containing elemental iron.

<http://www.andromeda.rutgers.edu/~geology/Faculty/Slater/Wu%20ES&T2.pdf>

Mapping Oil Spills on Sea Water Using Spectral Mixture Analysis of Hyperspectral Image Data
Plaza, J., R. Perez, A. Plaza, P. Martinez, and D. Valencia, Univ. of Extremadura, Spain.
Chemical and Biological Standoff Detection III. Proceedings of SPIE--The International Society for Optical Engineering, Vol 5995, p 79-86, 2005

A novel automated hyperspectral target detection technique for determining the level of oil contamination of polluted areas on the shoreline is presented. The method is based on the simultaneous use of spatial and spectral information by extended mathematical morphology operations. Both simulated and real hyperspectral data collected over polluted areas are used in this work to illustrate the effectiveness of the proposed approach.

<http://www.umbc.edu/rssipl/people/aplaza/Papers/Conferences/2005.SPIE.Oilspills.pdf>

Mass Spectrometric Forensics of Explosives Using a Remotely Piloted Small Helicopter
Robbins, R.C., W.M. Lagna, and G.J. Roelant, U.S. Army, Aberdeen Proving Ground, MD.
Fifth Joint Service Scientific Conference on Chemical and Biological Defense Research, 17-20 November 2003, Hunt Valley, MD. NTIS: ADA449737, 4 pp, Oct 2005

When the federal government investigated an explosion that occurred at the Herrig Brothers Poultry Farm in Albert City, IA, on the morning of April 8, 1998, the explosion was determined to be the result of a propane leak. The normal method of monitoring propane leaks after explosion poses a safety risk when done by hand. Using this case as the working model, the investigators set forth to determine if a remotely controlled helicopter system would allow safe, remote monitoring of propane leaks, using mass spectrometry to confirm the results. Mass spectrometry is often used to investigate explosives, both in unexploded and post-exploded forms. The specific objective of the study was to determine if a small helicopter could be used to sample an explosive concentration of gas for analysis by mass spectrometry and further to determine if the explosive hazard was caused by either an accidental release of gaseous hydrocarbons or by intentional use of high explosives, such as TNT, RDX, or PENT.

<http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=ADA449737&Location=U2&doc=GetTRDoc.pdf>

MAX-DOAS Measurements of Formaldehyde in the Po-Valley

Heckel, A., A. Richter, T. Tarsu, and F. Wittrock (Univ. Bremen); C. Hak and I. Pundt (Univ. Heidelberg); W. Junkermann (IMK-IFU); J. P. Burrows (Univ. Bremen).

Atmospheric Chemistry and Physics, Vol 5, p 909-918, 2005

During the 4-week measurement campaign of the EU FORMAT project in summer 2002 near Milan, northern Italy, ground-based scattered light differential optical absorption spectroscopy (DOAS) measurements were performed using a new multi-axis instrument. Slant column densities for formaldehyde (HCHO) and the oxygen dimer (O₄) were retrieved using fitting windows from 335 nm to 357 nm and 350 nm to 360 nm, respectively. To convert slant into vertical columns, radiative transfer calculations were performed using aerosol parameters derived from the actual O₄ measurements. By analyzing the measurements from different viewing directions (zenith, 4x off-axis), vertical profile information (especially mixing ratios for the boundary layer) have been derived for the first time for HCHO with a multi-axis DOAS (MAX-DOAS) instrument. The MAX-DOAS measurements were in excellent agreement with simultaneous measurements from both a long-path DOAS and a Hantzsch in situ instrument operated at the same place.

<http://www.copernicus.org/EGU/acp/acp/5/909/acp-5-909.pdf>

Measurement of Atmospheric Ammonia at a Dairy Using Differential Optical Absorption Spectroscopy in the Mid-Ultraviolet

Mount, G., B. Rumburg, J. Havig, B. Lamb, H. Westberg, D. Yonge, K. Johnson, and R. Kincaid.

Atmospheric Environment, Vol 36 No 11, p 1799-1810, 2002

Typical concentrations of ammonia in the boundary layer range from < 1 part per billion by volume (ppbv) in the free continental troposphere to parts per million (ppmv) levels over animal waste lagoons and near animal stalls, particularly dairy farms. A project at the Washington State University research dairy is underway to quantify ammonia emissions with a new instrument utilizing differential optical absorption spectroscopy (DOAS) to measure ammonia in the mid-ultraviolet with a detectability limit of about 1 ppb. Initial results show concentrations in the barn/concrete yard areas in the tens of ppm range, over the slurry lagoons of hundreds of ppb to low ppm, and low ppm levels after initial slurry applications onto pastureland. The initial data are discussed.

The Measurement of DNAPL in Low-Permeability Lenses Within Alluvial Aquifers by Partitioning Tracers

Jackson, R.E. and M. Jin, INTERA Inc., Niwot, CO.

Environmental and Engineering Geoscience, Vol 11 No 4, p 405-412, 2005

Where gaseous partitioning tracers are used in the vadose zone, critics maintain that the partitioning tracers will necessarily follow cleaned pathways created during soil vapor extraction and will thus bypass DNAPL zones. In the ground-water zone, the criticism is that it fails to detect DNAPL in low-permeability lenses either in the middle or at the base of aquifers, again because of bypassing. This paper presents numerical simulations of two laboratory experiments that demonstrate that the criticisms are incorrect and the partitioning

interwell tracer test (PITT) will accurately detect residual NAPL volume when proper design and field implementation are undertaken.

Measurements of the Ring Effect in the Near-Ultraviolet

Langford, A.O., R. Schofield, M. Melamed, J.S. Daniel, R.W. Portmann, and S. Solomon, NOAA ESRL CSD (formerly Aeronomy Laboratory), Boulder, CO.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

The filling-in (FI) of Fraunhofer features (the Ring effect) in scattered sunlight is recognized as a potential source of error in DOAS measurements. Measurements of FI are relatively scarce and often contradictory, but it is generally accepted that rotational raman scattering (RRS) is the primary mechanism for FI at near UV wavelengths. Aerosols and clouds increase or decrease this effect by changing the path of scattered light through the atmosphere. The contribution of FI to DOAS measurements has generally been corrected through the use of measured Ring cross-sections that treat FI as a pseudo-absorber, or by model calculations that assume RRS as the only source. The latter approach is particularly important for satellite observations at shorter wavelengths where the apparent Ring cross-sections are difficult to measure. Measurements are described of FI in the near-UV (320-380 nm) zenith-scattered sky light under clear and cloudy sky conditions in Boulder, CO. The impact of aerosols and clouds on the degree of FI is examined and compared to the observations with simple single- and double- scattering models that assume RRS as the responsible mechanism.

Measurements of Trace Gas Distributions Using Long-Path DOAS-Tomography During the Motorway Campaign BAB II: Experimental Setup and Results for NO₂

Pundt, I., K.-U. Mettendorf, T. Laepple, and V. Knab (Univ. of Heidelberg, Germany); P. Xie (Anhui Inst. of Optics and Fine Mechanics, Hefei, China); J. Losch, C.V. Friedeburg, U. Platt, and T. Wagner (Univ. of Heidelberg).

Atmospheric Environment, Vol 39, p 967-975, 2005

The tomographic differential optical absorption spectroscopy (Tom-DOAS) technique is presented with results from a first application. The technique can measure 2- and 3-dimensional concentration fields of different trace gases (e.g. NO₂, SO₂, ozone) in the planetary boundary layer on a small scale (100 to 10,000 m) by multiple light paths. Ways to use telescopes, lamps, retroreflector arrays, and spectrometers for the simultaneous measurement of many light paths are proposed. This paper discusses the results from the first long-path Tom-DOAS experiment next to a German motorway, which was part of the BAB II campaign in the spring of 2001. Sixteen different light-path vertical profiles on both sides of the motorway and a 2-D map of the NO₂ vehicle emission plume were derived from the measurements obtained.

<http://www.imk.uni-karlsruhe.de/download/BAB-Pundt.pdf>

Mercury Emissions from the Idrija Mercury Mine Measured by Differential Absorption Lidar Techniques and a Point Monitoring Absorption Spectrometer

Gronlund, R., H. Edner, S. Svanberg, J. Kotnik, and M. Horvat.

Atmospheric Environment, Vol 39 No 22, p 4067-4074, July 2005

Mercury emission measurements from the Idrija mercury mine in Slovenia were performed during an early November 2003 campaign. The differential lidar technique was used to map mercury concentrations, and an attempt was made to quantify the total mercury flux from the most contaminated area, an abandoned cinnabar roasting oven complex. Lidar concentration data were compared with data recorded with a Zeeman modulated atomic absorption instrument, operated from a vehicle equipped with a GPS localization system. Concentrations and fluxes were comparatively low due to low temperature and rainfall. The average flux measured from the distillation plant was approximately 2 g/h.

Metal Oxide Sensor Arrays for the Detection, Differentiation, and Quantification of Volatile Organic Compounds at Sub-Parts-Per-Million Concentration Levels

Wolfrum, E.J. (National Renewable Energy Lab, Golden, CO); R.M. Meglen (Latent Structures, LLC, Boulder, CO); D. Peterson and J. Sluiter (National Renewable Energy Lab).
Sensors and Actuators, B: Chemical, Vol 115 No 1, p 322-329, 23 May 2006

Sensor arrays were constructed using commercially available Figaro TGS2602 heated metal oxide sensors. Partial least squares (PLS-2) calibration models developed using steady-state sensor array responses were able to detect, differentiate, and quantify different VOCs at concentrations commonly found in indoor environments.

Micro Flame-Based Detector Suite for Universal Gas Sensing

Manginell, R., C. Washburn, M. Moorman, T. Hamilton, R. Manley, J. Miller, P. Lewis, P. Clem, and M. Okandan, Sandia National Labs, Albuquerque, NM.
SAND2005-6236, 36 pp, Oct 2005

A microflame-based detector suit has been developed for sensing of a broad range of chemical analytes. The detector combines calorimetry, flame ionization detection (FID), nitrogen-phosphorous detection (NPD), and flame photometric detection (FPD) modes into one platform based on a micro-combustor. The micro-combustor consists of a micro-machined micro-hotplate with a catalyst or low-work function material added to its surface. For the NPD mode, a low work-function material selectively ionizes chemical analytes; for all other modes, a supported catalyst such as platinum/alumina is used. The micro-combustor design permits rapid, efficient heating of the deposited film at low power. To perform calorimetric detection of analytes, the change in power required to maintain the resistive micro-hotplate heater at a constant temperature is measured. For FID and NPD modes, electrodes are placed around the micro-combustor flame zone and an electrometer circuit measures the production of ions. For FPD, the flame zone is optically interrogated to search for light emission indicative of de-excitation of flame-produced analyte compounds. The calorimetric and FID modes respond generally to all hydrocarbons, while sulfur compounds only alarm in the calorimetric mode, providing speciation. The NPD mode provides 10,000:1 selectivity of nitrogen and phosphorous compounds over hydrocarbons. The FPD can distinguish between sulfur and phosphorous compounds. The calorimetric, FID, and FPD modes can be achieved simultaneously on one micro-combustor, which makes it possible to form a universal chemical detector array with as little as two micro-combustor elements. The authors discuss the demonstrated performance of the micro-combustor in each of the detection modes.

http://www.osti.gov/bridge/product.biblio.jsp?query_id=1&page=0&osti_id=875633

A Microbial Fuel Cell for Environmental Monitoring

Kim, Byung Hong, Korea Inst. of Science & Technology, Seoul, Korea.

The 4th International Symposium on Advanced Environmental Monitoring, 4-6 December 2002, Jeju, Korea.

Microorganisms that can couple the oxidation of organic compounds to electron transfer to electrodes offer the promise of self-sustaining systems that can effectively convert waste organic matter and renewable biomass into electricity. A fuel cell-type electrochemical cell powered by wastewater was used to enrich electrochemically active microbes. Within 4 weeks of enrichment, the COD of the wastewater dropped to less than 5% of the original value. The current generated from the mediator-less microbial fuel cell was directly proportional to the concentration of the fuel. Oligotrophic and copitrophic enrichment cultures were used to monitor low-value (up to 20 mg per liter) and high-value (over 10 mg per liter) biochemical oxygen demand, respectively. A microbial fuel cell fed with a non-fermentable fuel (acetate) showed different responses against some metabolic inhibitors from a cell fed with fermentable fuels. These results suggest that toxic compounds can be monitored with microbial fuel cells using different fuels.

Micromechanical Sensors for Environmental Monitoring

Brown, G.M.; V.I. Boiadjev; P.V. Bonnesen; G. Goretzki; F. Tian; T. Thundat, Oak Ridge National Laboratory, Oak Ridge, TN. Meeting Abstracts, 208th Meeting of the Electrochemical Society, 16-21 October 2005, Los Angeles, CA. v MA 2005-02, 2005.

DOE's environmental remediation program needs rugged, low-cost sensing systems for real-time, in situ, chemical, physical, and radiological sensors to characterize and monitor underground waste tanks, groundwater, contaminated soil, and process streams. The use of several sophisticated instruments frequently is required to simultaneously achieve the desired selectivity and sensitivity for the complicated samples and matrices encountered in the environment. These instruments generally use a preliminary separation step followed by a sensitive but not necessarily selective detector. Microcantilever-based sensors have been shown to be extremely sensitive; however, silicon AFM microcantilevers coated on one surface with gold do not have any great chemical selectivity, particularly in solution. Chemical selectivity has been achieved by coating one side of the microcantilevers with a selective film, such as a self-assembled monolayer (SAM) of an alkanethiol reagent having a head group suitable for molecular recognition. The transduction part of the microcantilever sensor is based on binding the molecular recognition agent to one surface of the cantilever so that the adsorption-induced stress change can be detected via bending of the microcantilever. Selective coatings have been developed for sensing Cr(VI), Cs, Hg, Ca, Cu, HF, and H, and work is in progress to develop coatings that are selective for TcCV and Sr. The use of controlled potential electrochemical techniques offers an additional means of achieving chemical selectivity by controlling the potentials at which oxidation and reduction reactions occur at the microcantilever. Microcantilever deflection can be measured following electrochemical processes under circumstances in which the current is too small to conveniently measure. The development of microcantilever sensors for Hg, Cs, CrO₄²⁻, Cu²⁺, and other metal ions and the use of gold-coated cantilevers as electrodes in electrochemical reactions is discussed, including the combination of microcantilever deflection and anodic stripping voltammetry. A new Cs⁺ ion-selective ligand based on a calix[4]arene crown ether platform has been synthesized, and a SAM

of this ligand on a gold coated microcantilever was demonstrated to be exceptionally stable. The deflection response of a microcantilever modified with these ligands to Cs⁺ and K⁺ as a function of the concentration of NaNO₃ background electrolyte is presented.

Miniaturized Lead Sensor Based on Lead-Specific DNAzyme in a Nanocapillary Interconnected Microfluidic Device

Chang, I.-H., J. Tulock, J. Liu, W.-S. Kim, D. Cannon Jr., Y. Lu, P. Bohn, J. Sweedler, D. Cropek.

Environmental Science & Technology, Vol 39, p 3756-3761, 2005

A miniaturized lead sensor has been developed by combining a lead-specific DNAzyme with a microfabricated device containing a network of microfluidic channels that are fluidically coupled via a nanocapillary array interconnect. A DNAzyme construct forms a molecular beacon that is used as the recognition element. The nanocapillary array membrane interconnect is used to manipulate fluid flows and deliver the small-volume sample to the beacon in a spatially confined detection window where the DNAzyme is interrogated using laser-induced fluorescence detection. The sensor has been applied to the determination of Pb²⁺ in an electroplating sludge reference material, the result agreeing with the certified value within 4.9%. Combining a DNAzyme with a microfluidic-nanofluidic hybrid device makes it possible to change the DNAzyme to select for other compounds of interest, and to incorporate multiple sensing systems within a single device for greater flexibility. The goal of this research is the development of a robust field sensor for lead in groundwater or drinking water.

<http://montypython.scs.uiuc.edu/paper.htm>

Molecular Biological Tools

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 20 pp, June 2006

Molecular biological tools (MBTs) are field and laboratory tests that can measure the presence and activity of microbes at a site. They can be used to assess the performance of monitored natural attenuation and bioremediation remedies. A few MBTs are already used to support field-scale projects, and newer technologies continue to emerge. This Web Tool provides an introduction to MBTs applied through gene-based, lipid-based, protein-based, and isotope-based approaches. It also highlights the use of these new techniques at several Navy sites.

<http://www.ert2.org/ert2portal/DesktopDefault.aspx>

Molecular Characterization of Microbial Populations at Two Sites with Differing Reductive Dechlorination Abilities

Rahm, B.G., S. Chauhan, V.F. Holmes, T.W. Macbeth Jr., K.S. Sorenson, and L. Alvarez-Cohen, Univ. of California-Berkeley.

Biodegradation, Vol 14, p 1-12, Feb 2006

Three molecular techniques--terminal restriction fragment length polymorphism (T-RFLP), RFLP analysis with clone sequencing, and quantitative PCR (Q-PCR)--were compared for surveying differences in microbial communities at two contaminated field sites exhibiting differing chlorinated solvent degradation activities. At the Idaho site, trichloroethene (TCE) was

completely converted to ethene during biostimulation with lactate. At the California site, perchloroethene (PCE) was degraded only to cis-dichloroethene (cDCE) during biostimulation but was degraded to ethene after bioaugmentation with a culture containing dechlorinating *Dehalococcoides* strains. Q-PCR targeting of the 16S rRNA gene of *Dehalococcoides* strains showed a significant population at the Idaho site, but no detectable population at the California site prior to bioaugmentation. Q-PCR revealed the presence of *Dehalococcoides* in an uncontaminated well at the Idaho site, which suggests that the difference in dechlorination ability at the two sites was due to the initial absence of *Dehalococcoides* at the California site. Of the techniques tested, Q-PCR quantification of specific dechlorinating species provided the most effective and direct prediction of community dechlorinating potential.

Monitoring of Effluent DOM Biodegradation Using Fluorescence, UV and DOC Measurements
Saadi, I. (Newe Ya'ar Research Center, Ramat Yishay, Israel); M. Borisover; R. Armon; Y. Laor.
Chemosphere, Vol 63 No 3, p 530-539, 3 Apr 2006

The potential of effluent-dissolved organic matter (DOM) to undergo microbial degradation was assessed in batch experiments using effluent samples from a wastewater treatment plant. The samples were incubated with either effluent or soil microorganisms for 2 to 4 months and then characterized by dissolved organic carbon contents, UV₂₅₄ absorbance, and fluorescence excitation-emission matrices. Three main fluorescence peaks were identified that were attributed to humic/fulvic components and "protein-like" structures. During biodegradation, specific fluorescences of the three peaks increased at different extents, suggesting selective degradation of non-fluorescing constituents. In some cases, increase in the effluent fluorescence was observed, which suggested the formation of new fluorescing material associated with DOM biodegradation and/or the degradation of certain organic components capable of quenching DOM fluorescence. Different biodegradation dynamics for fluorescent DOM constituents as compared with other UV-absorbing molecules were delineated.

Monitoring Subsurface Microbial Ecology in a Sulfate-Amended, Gasoline-Contaminated Aquifer

Sublette, K. (Univ. of Tulsa, Tulsa, OK); A. Peacock; D. White; G. Davis; D. Ogles; D. Cook; R. Kolhatkar; D. Beckmann; X. Yang.

Ground Water Monitoring and Remediation, Vol 26 No 2, p 70-78, Spring 2006

When a 15-month field trial was conducted in an unconfined, gasoline-contaminated aquifer in fractured sedimentary bedrock to determine the efficacy of enhancing the attenuation of benzene, toluene, ethylbenzene, and xylenes (BTEX) hydrocarbons at the site by continuously amending the aquifer with sulfate to stimulate anaerobic bacteria, Bio-Sep(R) biotrap (Microbial Insights Inc., Rockford, TN) were used to monitor the subsurface microbial ecology in the aquifer during sulfate injection. Sulfate injection was shown to increase the rates of biodegradation of BTEX components more than twofold for toluene and about fivefold for gasoline-range hydrocarbons. The depletion of the subsurface microbial community in the aquifer showed that the aquifer became more anaerobic in character as sulfate utilization increased. In a comparison of the bead biofilms to planktonic samples, the bead biofilm biomarkers correlated with changes in ground water geochemistry during sulfate injection, while planktonic samples remained relatively unchanged over time.

Monitoring the Exhaust Air of a Compost Pile as a Process Variable with an E-Nose
Romain, A.C., D. Godefroid, M. Kuske, and J. Nicolas, Univ. de Liege, Arlon, Belgium.
Sensors and Actuators, B: Chemical, Vol 106 No 1, p 29-35, 29 April 2005

An emission chamber was developed for monitoring the composting process and placed over a household waste compost pile. A lab-made e-nose with metal oxide sensors was installed at the exit of this chamber. The e-nose measurements, air sampling on sorbent tubes, and physicochemical analysis are done simultaneously. The adsorbed air samples were analyzed in the lab by gas chromatography coupled to mass spectrometry (GC/MS). Correlation between the sensors and 14 chemical families was determined by principal component analysis. Two models were developed and calibrated by the proportion of each chemical family with the compost process progress. The models enabled monitoring of various kinds of compost process events with only one measurement device. [Erratum in Vol 115 No 1, p 558, 23 May 2006]

MSA SafEye Open Path Gas Detection System Now Available in Stainless Steel Version
Offshore-technology.com, 2 February 2005

The SafEye(R) Gas Detection System, a long-range open-path system, is available with a stainless steel housing option. The stainless steel enclosure protects the system in harsh environments such as chemical plants, where high levels of exposure to corrosive chemicals is possible. The heavy-duty housing, featuring sealed windows, can also be used on offshore oil rigs, where salt spray is a major concern. The SafEye System can detect hydrocarbons and toxic gases up to the lower explosive limit (LEL). Detection of these gases is performed over an open path of up to 450 feet (135 meters). Open-path gas monitoring is very cost-effective, providing gas detection coverage of an open area along a line of sight. Standard point-type gas monitors provide coverage only at the location of the sensor. Another advantage of open-path monitoring is lower installation and maintenance costs, as one SafEye Gas Detector can replace ten or more point-type detectors. The SafEye Gas Detection System can be used in many applications: fence line monitoring for chemicals or hydrocarbon vapors leaving the plant site, fuel or chemical tank leak detection at storage sites or loading areas, pipeline or vent stack monitoring of toxic and combustible gases, and compressor and pumping station monitoring. By using the optional ultraviolet source and detector, hydrogen sulfide (H₂S) and aromatic hydrocarbons such as benzene, toluene, and xylene can also be detected. The detector's 4-20 mA output can be connected to any type of monitoring or control unit, and an optional RS-485 communication link provides a local networking interface of as many as 128 detectors. Relay contacts are provided for both the IR and UV channels.

Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS).
Honninger, G., C. von Friedeburg, and U. Platt, Univ. of Heidelberg, Heidelberg, Germany.
Atmospheric Chemistry and Physics, Vol 4 No 1, p 231-254, 2004

Multi-axis differential optical absorption spectroscopy (MAX-DOAS) in the atmosphere is a novel measurement technique that represents a significant advance on the well-established zenith scattered sunlight DOAS instruments, which are mainly sensitive to stratospheric absorbers. MAX-DOAS utilizes scattered sunlight received from multiple viewing directions, and the spatial distribution of various trace gases close to the instrument can be derived by combining several viewing directions. Ground-based MAX-DOAS is highly sensitive to

absorbers in the lowest few kilometers of the atmosphere, and vertical profile information can be retrieved by combining the measurements with radiative transfer model (RTM) calculations. A Monte Carlo RTM can be applied to calculate airmass factors (AMF) for the various viewing geometries of MAX-DOAS. The airmass factors can be used to quantify the light path length within the absorber layers. A brief description is provided of the instrumental MAX-DOAS systems developed and deployed so far. The RTM study results are compared to several examples of recent MAX-DOAS field experiments.

<http://www.atmos-chem-phys.net/4/231/2004/acp-4-231-2004.pdf>

Multi-Axis-DOAS Measurements of NO₂ During the BAB II Motorway Emission Campaign
Friedeburg, C.v., I. Pundt, K.-U. Mettendorf, T. Wagner, and U. Platt, University of Heidelberg.
Atmospheric Environment, Vol 39, p 977-985, 2005

Slant column densities (SCD) of traffic-generated NO₂ were derived during the BAB II motorway emission campaign (April/May 2001) using scattered sunlight and a CCD-based Multi-Axis-(MAX) DOAS setup with eight viewing directions probed simultaneously. The setup allowed for the tracking of the diurnal variation of a motorway plume with 1 minute temporal resolution and an assessment of the vertical structure.

<http://www.imk.uni-karlsruhe.de/download/BAB-Friedeburg.pdf>

Multibeam Long-Path Differential Optical Absorption Spectroscopy Instrument: A Device for Simultaneous Measurements Along Multiple Light Paths

Pundt, I. and K.-U. Mettendorf.

Applied Optics, Vol 44 No 23, p 4985-4994, 2005

A novel long-path differential optical absorption spectroscopy (DOAS) apparatus for measuring tropospheric trace gases is a multibeam instrument, the first active DOAS device that emits several light beams simultaneously through only one telescope and with only one lamp as a light source. The instrument allows simultaneous measurement along multiple light paths, in contrast to conventional DOAS instruments. In the multibeam unit, several small mirrors are positioned near the lamp, creating multiple virtual light sources that emit one light beam each in one specific direction. The possibility of error due to scattering between the light beams is slight, and trace-gas detection limits of NO₂, SO₂, O₃, and H₂CO are similar to those of traditional long-path DOAS instruments.

Multi-Component Chemical Analysis of Gas Mixtures Using a Continuously-Tuneable Lidar System

Weibring, P. C. Abrahamsson, M. Sjoeholm, J.N. Smith, H. Edner, and S. Svanberg, Lund Inst. of Technology, Lund, Sweden.

Applied Physics B, Vol 79 No 4, p 525-530, Sep 2004

In differential absorption lidar (DIAL) measurements, the selection of more than two wavelengths is a mathematical necessity for simultaneous measurement of multiple species or for resolving interference effects between a compound of interest and a background gas, especially in the mid-IR region, where many hydrocarbon compounds have important spectral features. A method is presented for remote measurement of gas mixtures in the mid-IR region based on a

newly developed fast-switching, frequency-agile optical parametric oscillator lidar transmitter. Method performance was assessed via both indoor absorption cell measurements and outdoor remote range-resolved measurements of hydrocarbon mixtures.

A Multi-Level Pore-Water Sampler for Permeable Sediments

Martin, J.B. and K.M. Hartl (Univ. of Florida, Gainesville); D.R. Corbett; P.W. Swarzenski; J.E. Cable.

Journal of Sedimentary Research, Vol 73 No 1, p 128-132, Jan 2003

A multi-level piezometer (multisampler) is designed to collect porewater from permeable sediments up to 230 cm below the sediment/water interface. Multisamplers are constructed from 1-inch schedule 80 PVC pipe. One-quarter-inch flexible PVC tubing leads from eight ports at variable depths to a 1-inch tee fitting at the top of the PVC pipe. Multisamplers are driven into the sediment using standard fence-post drivers, and water is pumped from the PVC tubing with a peristaltic pump. This paper describes the construction and operation of the instrument, and the results of field tests that demonstrate the multisamplers' utility. The tests included collection of multiple samples from the permeable sediments, revealing mixing between shallow porewater and overlying lagoon water.

Nano Electrochemical Sensor and Its Measurement Electronics With a Dynamic Transduction Mechanism

Zhu, Xiaoshan, Ph.D. dissertation, University of Cincinnati, 168 pp, 2005

An interdigitated array (IDA) nanoelectrode with a dynamic transduction mechanism and its interface ASIC has been developed and characterized. The goal is to develop a highly sensitive electrochemical IDA nanosensor with simple instrumentation for the determination of reversible redox species. The key approach of the dynamic transduction mechanism, which has been explored in this work, is a charge injection method in which a charged capacitor is used as the charge supplier for the electrochemical reaction of the reversible redox species at the interdigitated array electrodes, and the characteristics of the capacitor (or electrode) potential decay are recorded and analyzed to evaluate the concentration of reversible redox species. A small surface-area IDA nanoelectrode with a finger width of 100 nm and a finger spacing of 200 nm has been fabricated using e-beam lithography for experiments after nano lift-off and mixed and matched nano/micro lithography processes were investigated in this research. The IDA nanoelectrode has achieved a detection limit of ~6 nM for the reversible redox species. Interface application-specific integrated circuit (ASIC) for the IDA nanoelectrode has been designed, fabricated, and fully characterized. The interface ASIC converts the sensing analog signal to the digital signal and provides a communication capability for microcontroller/microprocessor/DSP. Experimental results have shown that the IDA nanoelectrode using the charge injection method has a high potential as a new electrochemical nanocell for the detection of a single biochemical molecule, including DNA, proteins, or enzymes. The new electrochemical nanocell and the detection method can be easily integrated with the micro/nano analytical devices or systems for the trace determination with a low-cost, hand-held instrumentation or analyzer.

http://www.ohiolink.edu/etd/view.cgi?acc_num=ucin1122989975

Nanoelectronic Chemical Sensors: Theory and Experiment

Smardzewski, R.R., N.L. Jarvis, A.W. Snow, and H. Wohltjen.

Proceedings of the 2004 Scientific Conference on CBD Research, 15-17 Nov 2004, Hunt Valley, Maryland. NTIS: ADA449578, 7 pp, 2004

A new class of nano-scale, low-power, solid-state devices is being investigated for the detection of chemical weapons agents and other hazardous vapors. These nanoelectronic chemical vapor sensors, or "chemiresistors" comprise nanometer-sized gold particles (1.2 to 2.4nm) encapsulated by monomolecular layers of functionalized alkanethiols (R-SH) deposited as thin films on interdigitated microelectrodes. When chemical (agent, explosive) vapors reversibly absorb into these thin films, a large modulation of the electrical conductivity of the film is observed. The measured current between gold clusters is extremely sensitive to very small amounts of monolayer swelling or dielectric alteration caused by absorption of vapor molecules. For chemical agent simulants, a large dynamic range (5-logs) of sensitivities is observed and extends down to parts-per-billion vapor concentrations. For explosive vapors of TNT/DNT, detection limits in the femtogram range have been observed. Complete reversibility has been observed for all analyte vapors, and the devices exhibit relatively low sensitivity to water vapor (a major interferent). Tailored selectivities of the sensors are accomplished by incorporation of chemical functionalities at the terminal structure of the alkanethiol or substitution of the entire alkane structure.

<http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=A449578&Location=U2&doc=GetTRDoc.pdf>

Nanoparticle-Based Optical Biosensors for the Direct Detection of Organophosphate Chemical Warfare Agents and Pesticides

Simonian, A.L., T.A. Good, S.-S. Wang, and J.R. Wild.

Analytica Chimica Acta, Vol. 534 No 1, p 69-77, 2005

In a new biosensor for the direct detection of organophosphorus neurotoxins, the enzymatic hydrolysis of organophosphate (OP) neurotoxins by organophosphate hydrolase (OPH) generated two protons in each hydrolytic turnover through reactions in which P-X bonds are cleaved; however, the potentiometric method of detection limited the sensitivity of this biosensor. Other researchers reported that a change in fluorescence properties of a fluorophore in the vicinity of gold nanoparticles might be used for detection of nanomolar concentrations of DNA oligonucleotides. The detection strategy is based on the fact that an enhancement or quenching of fluorescence intensity is a function of the distances between the gold nanoparticle and fluorophore. The authors investigated the potential for exploiting the specificity of enzyme/substrate interactions in similar systems by preparing OPH/gold nanoparticle conjugates, then incubating them with a fluorescent enzyme inhibitor or decoy. The fluorescence intensity of the decoy was sensitive to the proximity of the gold nanoparticle, and thus could be used to indicate that the decoy was bound to the OPH. When different paraoxon concentrations were introduced to the OPH/nanoparticle/conjugate/decoy mixtures, the greatest sensitivity was obtained when decoys and OPH/gold nanoparticle conjugates were present at near equimolar levels. The change in fluorescence intensity was correlated with the concentration of paraoxon in the solution.

<http://www.eng.auburn.edu/~simonal/Simonian%20articles%20PDF/2005%20Analy.%20Chim.%20acta,%20Nanoparticle-based%20optical%20biosensors%20for%20OP%20Simonian.pdf>

Nanosensor for Toxic Ions

Evans, Caroline.

Chemistry World, Feb 2005

Though nanometer-sized low-dimensional semiconductors known as quantum dots (QDs) look promising for numerous applications, thus far the exploitation of QDs has mainly concentrated on optical imaging in biology and developments in optoelectronics. At the University of Oviedo, Alfredo Sanz-Medel and his colleagues theorized that QDs could also be used in chemical sensing. They modified the surface of cadmium selenide QDs to make them water soluble and examined their properties in aqueous solution. Not only is the luminescence emission of their modified QDs very sensitive to the presence of even very low concentrations of cyanide ions in aqueous solution, but it is also selective for the cyanide ion over other common anions.

Natural Attenuation of Chlorinated Solvent Ground-Water Plumes Discharging into Wetlands Lorah, M.M., D.R. Burris, and L.J. Dyer.

U.S. Geological Survey Scientific Investigations Report 2004-5220, 203 pp, 2005

A collaborative study by USGS and the Air Force Research Laboratory under DoD's Environmental Security Technology Certification Program was conducted to determine if the natural attenuation of chlorinated solvents that occurs at the Aberdeen Proving Ground (APG) wetland site in Maryland can occur at wetland sites in different hydrogeologic environments. The objectives were (1) to assess and compare the extent of natural attenuation of chlorinated solvents at the APG wetland site to an inland forested bog in the Colliers Mills Wildlife Management Area, near McGuire Air Force Base, NJ, (2) to demonstrate and compare different methods of sampling and analysis for collecting the site data needed to evaluate natural attenuation in wetlands, and (3) to develop a technical protocol for the assessment of natural attenuation of chlorinated solvent plumes discharging into wetlands. Section 3 contains a 30-page comparison of porewater sampling methods and evaluation of a voltammetric microelectrode to characterize natural attenuation in wetlands. Section 4 introduces the "Draft Technical Protocol for Characterizing Natural Attenuation of Chlorinated Solvent Ground-Water Plumes Discharging into Wetlands" as an addendum to AFCEE's 1996 Chlorinated Solvent Natural Attenuation Protocol.

<http://pubs.usgs.gov/sir/2004/5220/>

Navy Sediment Guide Data Sheet

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 16 pp, Feb 2006

Sediment site investigation and cleanup can be challenging because of the evolving state of the science and environmental regulations. In the past, Remedial Investigations (RIs) of impacted sediment typically involved sampling strategies based on those used at terrestrial sites, but the use of these methods is inappropriate due to the complexity of the aquatic environment. In addition, the evaluation of remedial alternatives in the Feasibility Study (FS) can be challenging because contaminated sediment remediation is a rapidly evolving field. NAVFAC has recently developed a guidance document to help Remedial Project Managers complete

successful RI/FS efforts at sediment sites, "Implementation Guide for Assessing and Managing Contaminated Sediment at Navy Facilities." This Web Data Sheet highlights the scope of the Guide and critical issues related to the RI/FS process at sediment sites.

<http://www.ert2.org/ert2portal/DesktopDefault.aspx>

Navy Sediment Investigation Data Sheet

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 16 pp, Mar 2005

This Web data sheet presents new sediment characterization methods studied by the Office of Naval Research. These methods are currently being field-tested at several Navy sites. Navy remedial project managers can use these methods to provide evidence of biodegradation, to quantify the effects of seasonal variation, to estimate contaminant transport, and to measure background contamination in industrialized watersheds. All of these lines of evidence can be used to make defensible and cost-effective risk and remedial management decisions. In addition, the use of these new methods in the context of Navy policy and guidance for sediment site investigations is discussed.

<http://www.ert2.org/ert2portal/DesktopDefault.aspx>

New Application Software for Differential Optical Absorption Spectroscopy (DOAS)

Merten, Andre, Heidelberg Univ., Germany.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

The opportunity offered by differential optical absorption spectroscopy (DOAS) to perform automatic measurement and analysis of atmospheric trace gases has been limited by the lack of adequate software. A new, easier to handle DOAS software based on Labview has been developed that can be used to monitor trace gases. The software offers complete control by graphical user interface, an automatic documentation mode, and remote control via LAN or Internet. Both passive and active DOAS devices (long-path telescope, White Cell) can be controlled. An automatic trace gas monitoring system based on a long-path telescope with modern LED light source is presented that can supervise air quality in both urban locales and hazardous industrial areas.

A New In Situ Method to Analyze Mineral Particle Reactions in Soils

Birkefeld, A., R. Schulin, and B. Nowack, Swiss Federal Inst. of Technology, Zurich (ETH), Schlieren, Switzerland.

Environmental Science & Technology, Vol 39 No 9, p 3302-3307, 2005

A simple method has been developed to monitor the transformation of particles in soils under in situ conditions. The particles are fixed on small polymer supports (2 cm x 2 cm) with a thin film of epoxy resin, which allows the particles to be put into close contact with soil at a chosen site and easily recovered after extended periods of time. The method was tested with lead oxide and copper concentrate in the field. The method has the potential to be used in other environmental media, such as sediments or water, to study the reactions of a variety of particles larger than 20 um.

<http://www.ito.ethz.ch/SoilProt/staff/nowack/publications.html>

A New Retrieval Method for Tropospheric Ozone Profiles from a Ground-based Ultraviolet Spectrometer

Liu, Xiong, Kelly Chance, and Christopher E. Sioris (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA); Michael J. Newchurch (Univ. of Alabama, Huntsville); Thomas P. Kurosu (Harvard-Smithsonian Center for Astrophysics).
Applied Optics, Vol 45 No 10, p 2352-2359, Apr 2006

A new method is presented for the retrieval of tropospheric ozone (O₃) profiles from ground-based ultraviolet spectroscopic measurements. This method utilizes radiance spectra in the Huggins bands (i.e., 300-340 nm) measured at three off-axis angles (e.g., 45, 75, and 85 degrees) normalized to direct-sun irradiances or zenith-sky radiances with the total-column O₃ derived from direct-sun or zenith-sky measurements as a constraint. The vertical resolution of the retrieved O₃ values ranges from ~3 km near the surface to ~12 km at 20-km altitude. This method can be used to measure diurnal variation of tropospheric O₃ profiles and is complementary to the Umkehr method that mainly measures ozone profiles in the stratosphere.
http://www.atmos.uah.edu/atmchem/pub/fulltext/r2005/gndspec_manuscript_accepted.pdf

New Scanning Infrared Gas Imaging System (SIGIS 2) for Emergency Response Forces

Harig, R., G. Matz, P. Rusch, H.-H. Gerhard, J.-H. Gerhard, and V. Schlabs, Hamburg Univ. of Technology, Germany.

Chemical and Biological Standoff Detection III. Proceedings of SPIE--The International Society for Optical Engineering, Vol 5995, p 174-181, 2005

A remote sensing system that allows the identification of hazardous clouds from long distances is among the equipment to be used by emergency response forces in Germany. A new scanning infrared gas imaging system, SIGIS 2, is currently being developed that is based on an interferometer with a single detector element (Bruker OPAG 33) in combination with a telescope and a synchronized scanning mirror. The new scanning system allows 360-degree surveillance. The system is equipped with a video camera, and the results of the analyses of the spectra are displayed by an overlay of a false color image on the video image, thus allowing a simple evaluation of the position and the size of a cloud. This paper describes the new interferometer, the new scanning system, the data analysis method, and first results of measurements.

A New Tool for the Rapid Remote Detection of Leaks from Subsea Pipelines During Remotely Operated Vehicle Inspections

McStay, D.; J. McIlroy; A. Forte; F. Lunney; T. Greenway; K. Thabeth; G. Dean.
Journal of Optics A: Pure and Applied Optics, Vol 7 No 6, p S346-S351, June 2005

A new subsea sensor rated for 2000-m depth can effectively, rapidly, and remotely detect leaks of fluorescein dye, leak detection chemicals, and hydraulic fluids from underwater structures. The system projects a structured beam of light into the water column, using ultra-bright LED technology at a wavelength suitable to excite the fluorescence of the target material. Digital signal processing is used to extract the intensity from the fluorescing target material. The system is capable of detecting ppm concentrations of fluorescein at a range of 2.5 m in water in real time. This effective, user-friendly remote detection capability is also highly effective for probing complex underwater structures.

A Novel System for Conducting Biosorption Studies with Microorganisms

Baxter, M. and J.H. Brown (City Univ. of New York, Bronx); R.F.E. Crang (Univ. of Illinois, Urbana); M.C. Hitt (Univ. of Maryland Medical Center, Baltimore); and T.E. Jensen (CUNY). ICPEP-3: Proceedings of the Third International Conference on Plants and Environmental Pollution, 29 November - 2 December 2005, Lucknow, India. Book of Abstracts, p 57, abstract SV/P-9, 2005

The authors describe a system designed to support microbial studies of biosorption. The system involves the formation of alginate beads that encapsulate microorganisms and flow cylinders designed to hold the beads while they are supplied with a continuous flow of growth media, an exchange of fluids, and a flow of nitrogen to simulate microaerophilic conditions, plus an access for sampling fluid and/or alginate beads as needed. Each bead is 1.5 to 2.0 mm in diameter and can be made to incorporate a uniform amount of microorganism cells, thus making cell sampling by weight or volume unnecessary. The beads encapsulate the cells so that they are not lost in filtration, or mechanically damaged in transfer from one medium to another. The bead maker is designed for gravity flow of sodium alginate and concentrations of cells fully mixed through a plate of numerous beveled pores. Encapsulated cells can be embedded in various media and checked for viability by staining with fluorescein diacetate and observation in a UV-fluorescent microscope. The flow cells are constructed to allow for a variety of experimental conditions, as well as for the monitoring of elements and heavy metals through an access port that does not interrupt the normal flow conditions of nutrients or microaerophilic levels.

NSF Pumps \$75M into New ERCs

SSTI Weekly Digest for September 4, 2006

Synthetic biology, quality of life technologies, fluid power, mid-infrared technologies, and structured organic composites are the five technology areas supported through the new Engineering Research Centers awards announced by the National Science Foundation. The centers will share \$75.3 million to develop cross-disciplinary research programs advancing technologies that address major societal problems and provide the basis for new industries. Mid-Infrared Technologies for Health and the Environment (MIRTHE) researchers will develop technologies that use mid-infrared quantum cascade lasers as the backbone for a wide range of next-generation air-monitoring sensors. Mid-infrared light reveals the presence of key gas molecules -- such as carbon dioxide, ammonia, methane, and benzene -- to specialized sensors. Such sensors have the potential to be accurate, extremely compact, affordable and easy for non-specialists to operate. MIRTHE is based at Princeton University in partnership with Johns Hopkins University, the University of Maryland, Baltimore County (UMBC), Rice University, Texas A&M, and the City College of New York. The center is collaborating with dozens of industrial partners and several educational outreach partners.

Occurrence of Iodo-Acid DBPs in U.S. Chloraminated Drinking Waters

Richardson, S.D., J.J. Ellington, F.G. Crumley, J.J. Evans (U.S. EPA, Athens, GA); M.J. Plewa and E.D. Wagner (Univ. of Illinois).

The 231st ACS National Meeting, Atlanta, GA, March 26-30, 2006, ENVR 33.

Iodo-acids were recently identified for the first time as disinfection byproducts (DBPs) in drinking water disinfected with chloramines. The iodo-acids identified included iodoacetic acid (IAA), bromiodoacetic acid, (E)-3-bromo-3-iodo-propenoic acid, (Z)-3-bromo-3-iodo-propenoic acid and (E)-2-iodo-3-methylbutenedioic acid. There is concern about these new iodo-acid DBPs because mammalian cell toxicity studies have revealed that IAA is highly cytotoxic and genotoxic. New evidence indicates that iodinated DBPs may be increased in formation in chloraminated vs. chlorinated drinking water, and this is of concern because many water utilities are switching from chlorine to chloramines. A negative chemical ionization mass spectrometry method is being developed to measure these iodo-acids in drinking water for use in a large occurrence study of the iodo-acids in chloraminated drinking waters across the United States.

On-Board Processing for Spectral Remote Sensing

Gomez, Richard B. and Ambrose J. Lewis, George Mason Univ., Fairfax, VA.

ISPRS Special Session Future Intelligent Earth Observing Satellites (FIEOS) 10 -15 November 2002, Denver, Colorado. 5 pp.

Hyperspectral imaging (HSI) is proving to be one of the most powerful remote sensing techniques available. The cost of this approach is the generation of huge datasets that require fairly sophisticated computational techniques to exploit. The purpose of this paper is to show that these computational difficulties can be somewhat mitigated by using techniques from other areas in information technology. First, the paper introduces the concept of real-time systems to familiarize the reader with this area. Second is a discussion on the potential application of hardware clustering as a methodology to increase overall system performance and throughput. Included is a brief overview of the software libraries that can be used to perform parallel processing within such a hardware cluster. Third is an overview of spectral libraries and exemplar spectra. Effective utilization of these two system components is critical to the computationally intensive pixel unmixing and classification algorithms. Following this introduction is a discussion about the proposed Spectral Information Management Architecture (SIMA), which is proposed as a technique for organizing and structuring spectral information.

<http://scs.gmu.edu/~rgomez/fall01/HSI%20Papers/On-Board%20Processing/FIEOS%20Spectral%20Paper.doc>

An Open-Path, Hand-Held Laser System for the Detection of Methane Gas

van Well, Ben; S. Murray; J. Hodgkinson; R. Pride; R. Strzoda; G. Gibson; M. Padgett.

Journal of Optics A: Pure and Applied Optics, Vol 7 No 6, p S420-S424, June 2005

The described open-path hand-held gas detector incorporates a distributed feedback InGaAs laser diode at 1.65 μm . The emitted laser beam is backscattered from nearby surfaces, collected, and focused onto an amplified InGaAs detector using a 150 mm diameter plastic Fresnel lens. At ranges of 4 to 5 m, a typical backscattered signal is tens of nanowatts of laser light. Applying second derivative wavelength modulation spectroscopy gives a sensitivity to methane of better than 10 ppm over a 1-meter path length. Detector demonstration units have been fabricated and successfully evaluated by end users.

Optical Measurement Technology for Fugitive Emissions from Upstream Oil and Gas Facilities
Chambers, Allan, Alberta Research Council, Inc.
Petroleum Technology Alliance Canada, 79 pp, Dec 2004

The main focus of this project was a hydrocarbon emissions survey of one sweet gas processing plant and one sour gas processing plant. This survey was performed from July 27 to August 4, 2004 and included (1) quantification of the emissions of methane, C₂+ hydrocarbons, and benzene from each plant using a mobile differential absorption lidar (DIAL) unit operated by Spectrasyne Ltd., (2) identification of hydrocarbon leaks using the Hawk gas-leak imaging camera operated by Leak Surveys, Inc. The sour gas plant surveyed during this project had also been surveyed with the DIAL unit in 2003.

<http://www.ptac.org/env/dl/envp0403.pdf>

Optical Remote Sensing to Determine Strength of Nonpoint Sources: Duke Forest Control Experiments (ESTCP # CP-0214)

Varma, R., R. Hashmonay, R. Kagaan, and A. Bolch, ARCADIS Geraghty & Miller, Inc., Durham, NC.

Report No: AFRL-ML-TY-TR-2005-4584, 97 pp, Nov 2005

Under EPA and DOE support, Radial Plume Mapping (RPM) has been developed for the direct measurement of area sources. RPM uses a scanning optical sensor, and asymmetrically placed array of reflectors, wind measurements, and optimization algorithms to calculate area source emissions from non-point sources using open-path Fourier transform infrared (OP-FTIR) spectroscopy. Trace gases, nitrous oxide, ethylene and acetylene, propylene, and propane, were released in a controlled manner and their locations of release were recorded. By radial scanning on a horizontal plane close to the ground, the location of the point releases was reconstructed. Area sources were simulated with soaker hoses laid out in "H"-shape configurations. By scanning beams in a vertical plane downwind from the sources, the fluxes were computed and compared to the known actual release rates. The results show that the source locations were reconstructed successfully to within 10% of the diagonal length of the investigated area using the horizontal RPM, and the calculated mass flux agreed with the known release rates to within a few percent, under stable experimental conditions.

<http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=ADA440825&Location=U2&doc=GetTRDoc.pdf>

Optimal Design of a Groundwater Monitoring Network in Daqing, China

Wu, Y., Cold and Arid Regions Environmental and Engineering Research Inst. of CAS, Lanzhou, China.

Environmental Geology, Vol 45 No 4, p 527-535, Feb 2004

There are 34 groundwater well fields with a withdrawal rate of 81.9 x 10⁴ m³/d in the Daqing region of China. Over-extraction of the groundwater resources has caused a cone of depression up to 4,000 km² has formed in the area. Sites for monitoring the groundwater level were selected by applying the finite-element method coupled with Kalman filtering to the area in which the groundwater resources have been extensively exploited. The authors describe the process and method used to select additional sites to augment the existing observational well network for optimal long-term monitoring. An optimal monitoring network with 88 observation

wells with a measurement frequency of 12 times per year was selected in the Daqing region of China.

Ozone Detection by Differential Absorption Spectroscopy at Ambient Pressure with a 9.6 μm Pulsed Quantum-Cascade Laser

Jimenez, R., M. Taslakov, V. Simeonov, B. Calpini, F. Jeanneret (Swiss Federal Inst. of Technology (EPFL), Lausanne); D. Hofstetter, M. Beck, and J. Faist (Univ. of Neuchatel, Neuchatel, Switzerland); H. van den Bergh (EPFL).

Applied Physics B, Vol 78 No 2, p 249-256, Jan 2004

Direct absorption spectroscopic detection of ozone has been achieved at ambient pressure with a pulsed, DFB quantum-cascade laser (QCL) tuned within 1044-1050/cm by temperature scanning. Wavelength calibration curves were derived from FTIR and carbon dioxide spectra. The laser linewidth ($\sim 0.13/\text{cm}$ FWHM) was found to decrease with temperature, probably as a result of operation at constant current. Differential absorption was used to filter out spectral features resulting from baseline inaccuracies. Reference ozone concentrations were obtained by applying the same method to UV spectra, simultaneously measured with a differential optical absorption spectrometer (DOAS). The results show the applicability of the differential absorption method to QCL spectroscopy at ambient pressure and encourage its use for open path detection. http://lpas.epfl.ch/lidar/research/QCL/Jimenez_et%20al_2003%5Bo3_QCL%5D.pdf

Passive Diffusion Sampler Tool

U.S. Navy, Naval Facilities Engineering Command, Environmental Restoration Technology Transfer, Multimedia Training Tools website, 16 pp, Mar 2005

Passive diffusion bag (PDB) samplers can be used as an alternative method for sampling groundwater monitoring wells for volatile organic compounds (VOCs). Some of the main advantages of using PDBs instead of conventional sampling methods include lower costs, little or no turbidity present in samples, and the ability to vertically profile a monitoring well by collecting multiple samples. PDBs are typically composed of low-density polyethylene (LDPE) and contain deionized water. Samplers are placed in monitoring wells at a predetermined optimal depth or multiple depths, and remain in the wells until equilibrium has been reached between the water in the monitoring well and the water inside the PDB sampler. The bags are then removed from the wells and the water inside the sampling bags is bottled and sent for laboratory analysis. This Web Tool reviews the principles behind the use of PDBs and documents their deployment at Navy sites to facilitate the sharing of lessons learned.

<http://www.ert2.org/ert2portal/DesktopDefault.aspx>

Passive Standoff Detection of SF₆ Plumes at 500 Meters: Measurement Campaign to Support the Evaluation of Telops Imaging Spectrometer (FIRST)

Lavoie, H., E. Puckrin, and J.-M. Theriault, Defence R&D Canada, Valcartier.

DRDC Valcartier ECR 2004-373, NTIS: ADA437354, 38 pp, Aug 2005

This report presents the spectral measurements performed with CATSI on September 29, 2004, for the release of sulfur hexafluoride (SF₆) at 500 m. The measurements were obtained simultaneously with the Telops imaging sensor (FIRST) to validate the capability of the sensor

and to acquire a data set for the development and validation of the detection, identification, and quantification algorithms. The Gasem algorithm was used to detect, identify and quantify the released simulant (SF6) plume. The algorithm was set up to fit the column density and the spectral slope in function of the wavenumber. The column density was obtained for different background type and different simulant flow rate. The column densities obtained for a released plume over natural backgrounds were consistent with values obtained in other field trials. The column densities obtained for the artificial backgrounds were inconsistent with the values obtained for natural backgrounds, being as high as an order of magnitude greater than expected. At the moment, there is no obvious explanation for this difference.

<http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=A437354&Location=U2&doc=GetTRDoc.pdf>

Path Concentration Profile Reconstruction of Optical Remote Sensing Measurements Using Polynomial Curve Fitting Procedures

Wu, C.-F. (Univ. of Washington, Seattle); M.G. Yost; R.A. Hashmonay; M.-Y. Tsai.
Atmospheric Environment, Vol 37 No 14, p 1879-1888, May 2003

Open-path Fourier transform infrared (OP-FTIR) spectroscopy is one of several optical remote sensing (ORS) techniques that identify and quantify air pollutants via path-integrated measurements along the scanning beam path. The authors explored the use of a polynomial curve directly fitted to the path-integrated concentration data for this application. The derivative of the fitted curve is the reconstructed density function of the underlying line concentration profile.

Perchlorate-Selective Polymeric Membrane Electrode Based on a Cobaloxime as a Suitable Carrier

Zanjanchi, M.A., M. Arvand, M. Akbari, K. Tabatabaeian. and G. Zaraei, Univ. of Guilan, Rasht, Iran.

Sensors and Actuators B: Chemical, Vol 113 No 1, p 304-309, 17 Jan 2006

The authors present the development of a perchlorate-selective electrode based on cobaloxime ([chlorobis(dimethylglyoximateo)(triphenylphosphine)] cobalt (III), [Co(dmG)2pph3Cl]) incorporated in a plasticized poly(vinyl chloride) membrane. The electrode shows excellent selectivity toward perchlorate with respect to many common anions. The sensor was used to determine perchlorate in water and human urine.

Piezoelectric Quartz Crystal (PQC) with Photochemically Deposited Nano-Sized Ag Particles for Determining Cyanide at Trace Levels in Water

Sun, H., Y.Y. Zhang, S.H. Si, D.R. Zhu, and Y.S. Fung, Univ. of Hong Kong, Hong Kong SAR, China.

Sensors and Actuators B: Chemical, Vol 108 Nos 1-2, p 925-932, 22 July 2005

Piezoelectric quartz crystal (PQC) provides the base for a sensitive and cost-effective cyanide sensor for determining cyanide at trace levels in water. The sensing layers were fabricated by depositing photochemically generated nano-sized silver particles on titanium dioxide film at the electrode surface of the PQC. The freshly produced metallic Ag interacts strongly with cyanide, allowing reliable, quantitative determination of cyanide better than 30 times lower than the World Health Organization guideline value for drinking water.

Pipeline Structural Health Monitoring Using Macro-Fiber Composite Active Sensors

Thien, Andrew B., Master's thesis, University of Cincinnati, 176 pp, 2006

Pipeline accidents have resulted in hundreds of fatalities and billions of dollars in property damages. These accidents show that current monitoring methods are not sufficient and have considerable room for improvement. This thesis proposes a structural health monitoring (SHM) system for pipeline networks that will continuously monitor their structural integrity, thus reducing the overall risks and costs associated with current monitoring methods. The proposed SHM system relies upon the deployment of macro-fiber composite (MFC) patches for the sensor array. Because MFC patches are flexible and resilient, they can be permanently mounted to the curved surface of a pipeline's main body. From this location, the MFC patches are used to monitor the structural integrity of the entire pipeline. Two damage-detection techniques--guided wave and impedance methods--were implemented as part of the proposed SHM system. Both techniques utilize the same MFC patches. This dual use of the MFC patches enables the proposed SHM system to require only a single sensor array. Lamb wave methods are presented that demonstrate the ability to correctly identify and locate the presence of damage in the main body of the pipeline system, including simulated cracks and actual corrosion damage. The presented impedance methods demonstrate the ability to correctly identify and locate the presence of damage in the flanged joints of the pipeline system, including the loosening of bolts on the flanges. In addition to detecting damage to the pipeline itself, the proposed methods were used to demonstrate the capability of detecting deposits inside of pipelines. Monitoring these deposits can lead to timely action to prevent clogging and other hazardous situations. Suggestions are made regarding future research issues needed to advance the SHM technology toward the realization of commercial applications.

http://www.ohiolink.edu/etd/view.cgi?acc_num=ucin1140799131

Potential for Satellite Remote Sensing of Ground Water

Becker, Matthew W.

Ground Water, Vol 44 No 2, p 306-318, Mar/Apr 2006

The author explores the potential for remote sensing of groundwater in the context of active and planned satellite-based sensors. Satellite technology is reviewed with respect to its ability to measure groundwater potential, storage, and fluxes. It is argued here that satellite data can be used if ancillary analysis is used to infer groundwater behavior from surface expressions. Remotely sensed data are most useful where they are combined with numerical modeling, geographic information systems, and ground-based information.

Practical Field Application of a Novel BOD Monitoring System

Kim, M., S.M. Youn, S.H. Shin, J.G. Jang, S.H. Han, M.S. Hyun, G.M. Gadd, and H.J. Kim.

Journal of Environmental Monitoring, Vol 5, 640-643, 2003

A biochemical oxygen demand (BOD) monitoring system, based on electrochemically-active bacteria in combination with a microbial fuel cell, has been developed for the purpose of on-site, on-line, and real-time wastewater monitoring. A microbial fuel cell enriched with electrochemically-active bacteria provides the basis of the measurement system. In a 60-day test

of the system at a sewage treatment plant, the BOD monitoring system was successfully operated with high accuracy and good stability. The measuring period for a sample was 45 min. This application of the measurement system demonstrated a rapid and practical technique for determination of BOD5 in wastewater.

Precision Ground Water Sampling in Coastal Aquifers Using a Direct-Push, Shielded-Screen Well-Point System

Charette, Matthew A. and Matt C. Allen.

Ground Water Monitoring & Remediation, Vol 26 No 2, Spring 2006, p 87-93(7)

The authors describe the application of a commercially available gas vapor sampling probe to groundwater sampling in shallow coastal aquifers. The system involves a small-diameter, shielded-screen well-point sampler that can provide high resolution (~10 cm) to depths of 10 m or greater depending on the aquifer matrix. Examples are presented for system application in two geologically contrasting environments.

http://www.who.edu/science/MCG/groundwater/pubs/PDF/may06/Charette_Allen_GWMR.pdf

Quantification of Fugitive Reactive Alkene Emissions from Petrochemical Plants with Perfluorocarbon Tracers

Senum, G. and R.N. Dietz, Brookhaven National Laboratory, Upton NY.

BNL-73106-2004-IR, 17 pp, June 2004

Petrochemical plants located in and around the Houston area emit atmospheric alkenes, such as ethene, propene and 1,3-butadiene. The magnitude of emissions is a major uncertainty in assessing their effects. Even though the petrochemical industry reports that fugitive emissions of alkenes have been reduced to less than 0.1% of daily production, recent measurement data obtained during the TexAQS 2000 experiment indicate that emissions are perhaps a factor of ten larger than estimated values. Industry figures for fugitive emissions are based on adding up estimated emission factors for every component in the plant to give a total estimated emission from the entire facility. The dramatic difference between estimated and measured rates indicates either that (1) calculating emission fluxes by summing estimates for individual components is seriously flawed (possibly due to individual components leaking well beyond their estimated tolerances), (2) not all sources of emissions for a facility are being considered in emissions estimates, or (3) known sources of emissions are not being reported. This experiment was designed to confirm estimates of reactive alkene emissions derived from analysis of the TexAQS 2000 data by releasing perfluorocarbon tracers (PFTs) at a known flux from a petrochemical plant and sampling both the perfluorocarbon tracer and reactive alkenes downwind using the Piper-Aztec research aircraft operated by Baylor University. PFTs have been extensively used to determine leaks in pipelines, air infiltration in buildings, and to characterize the transport and dispersion of air parcels in the atmosphere. PFTs are inert, nontoxic, noncombustible and nonreactive. Up to seven unique PFTs can be released simultaneously, sampled, and analyzed, and the technology is well suited for determining emission fluxes from large petrochemical facilities. The PFT experiment described here was designed to quantitate alkene emissions from a single petrochemical facility.

<http://www.ecd.bnl.gov/pubs/BNL-73106-2004-IR.pdf>

Raman-Shifted Eye-Safe Aerosol Lidar

Mayor, Shane D. and Scott M. Spuler.

Applied Optics, Vol 43 No 19, p 3915-3924, July 2004

The transmitter in a new elastic backscatter lidar system utilizes stimulated Raman scattering in high-pressure methane to convert fundamental Nd:YAG radiation by means of the 1st Stokes shift. The wavelength-converting gas cell features multipass operation and internal fans. The pump beam is not focused in this configuration, thus preventing optical breakdown of the gas inside the cell. The gas cell is injection-seeded by a diode to improve conversion efficiency and beam quality. The receiver uses a 40.6-cm diameter telescope and a 200- μm InGaAs avalanche photodiode and is capable of operating in a dual-wavelength mode (1064 and 1543 nm simultaneously) for comparison, or in a completely eye-safe mode.

http://www.eol.ucar.edu/lidar/Mayor_Spuler_AO_2004.pdf

Rapid Sample Preparation and Bioanalytical Techniques for Efficient Screening of Organic Pollutants in the Environment

Nording, Malin L., Ph.D. dissertation, Umea University, Umea, Sweden. ISBN 91-7264-109-6, 57 pp, 2006

The work underlying this thesis assessed the potential utility of convenient sample preparation and bioanalytical techniques for rapidly screening various environmental matrices as useful complements to higher resolution methods. Initially, the utility of a simplified extraction technique followed by an enzyme-linked immunosorbent assay (ELISA) for detecting polycyclic aromatic hydrocarbons (PAHs) in authentic (unspiked) contaminated soils was explored. The results showed that there are relationships between the structure and cross-reactivity among compounds that often co-occur with target PAHs; however, their potential contribution to deviations between estimates of total PAH contents of soils obtained using ELISA and gas chromatography-mass spectrometry (GC-MS)-based reference methods was limited. Instead, the cross-reactivity of target PAHs and the failure to extract all of the PAHs prior to the ELISA determinations were the main reasons for these deviations. Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were detected in food and feed matrices, as well as in authentic contaminated soils using different bioanalytical techniques: ELISA and the cell-based bioassays CAFLUX and CALUX (chemically activated fluorescent/luciferase gene expression). Enhanced sample preparation techniques based on accelerated solvent extraction (ASE) were developed as well. ASE with integrated carbon fractionation (ASE-C) in combination with CAFLUX produced estimates of PCDD and PCDF contents in fish oil and fish meal that agreed well with results obtained using reference methods. Results from ELISA and GC high-resolution MS analyses of extracts of PCDD- and PCDF-contaminated soil samples obtained using an adjusted ASE-C technique were strongly correlated. When compared to the results obtained using a reference method, all the bioanalytical techniques were found to be sufficiently sensitive, selective, and accurate for use in screening in compliance with soil quality assessment criteria; however, further validation must be undertaken prior to their large-scale application.

<http://www.diva-portal.org/umu/theses/abstract.xsql?dbid=842>

Rapid Screening of Dioxin-Contaminated Soil by Accelerated Solvent Extraction/Purification Followed by Immunochemical Detection

Nording, M. (Umea Univ., Sweden); M. Nickkova; E. Spinnel; Y. Persson; S.J. Gee; D.B. Hammock; P. Haglund.

Analytical and Bioanalytical Chemistry, Vol 385 No 2, p 357-366, May 2006

Trace analysis of dioxins in complex matrices requires exhaustive extraction, extensive cleanup, and very sensitive detection methods, traditionally involving the use of Soxhlet extraction and multi-step column cleanup, followed by gas chromatography/high-resolution mass spectrometry (GC/HRMS). Bioanalytical techniques may allow much more rapid, cost-effective screening via a novel approach based on simultaneous accelerated solvent extraction (ASE) and purification, followed by an enzyme-linked immunosorbent assay (EUSA). Both the traditional and the novel cleanup and detection approaches were applied to contaminated soil samples, and the results were compared. ELISA and GC/HRMS results for Soxhlet-extracted samples were linearly correlated, though the ELISA method slightly underestimated the dioxin levels, and the use of a safety factor is recommended to avoid an unacceptable rate of false-negative results. Relative abundance of the PCDDs/PCDFs evaluated by principal component analysis also affected ELISA performance; to minimize this effect, the results may be corrected for differences between the ELISA cross-reactivities and the corresponding toxic equivalency factor values. The GC/HRMS and ELISA results obtained following the two sample preparation methods agreed well, and the ELISA and GC/HRMS results for ASE extracts were strongly correlated. The ASE procedure combined with ELISA analysis appears to be an efficient approach for high-throughput screening of samples of PCDD/PCDF-contaminated soil.

REAL: 1.5 Micronwavelength Scanning Polarization Lidar

Mayor, S.D., S.M. Spuler, B.M. Morley, E. Loew, T.M. Weckwerth, S. De Wekker, and D.J. Kirshbaum, National Center for Atmospheric Research, Boulder, CO.

23rd International Laser Radar Conference, 24-28 July 2006, Nara, Japan

The National Center for Atmospheric Research's Raman-shifted eye-safe aerosol lidar (REAL) has been upgraded to feature backscatter polarization sensitivity deployed in several field experiments. This paper describes the hardware improvements added to enable the polarization capability and observations of various types of aerosol plumes released on a military test range. The REAL was also deployed as part of the NSF-sponsored T-REX experiment in March of 2006 in order to visualize the atmospheric flow in the Owens Valley of California. Examples of data from that experiment are shown. A second-generation REAL has been created by ITT Industries for continuous and unattended operation.

http://www.eol.ucar.edu/lidar/real/Mayor_et_al_ILRC23_Rev.pdf

Real-Time Detection Method and System for Identifying Individual Aerosol Particles

Gard, Eric Evan and David Philip Fergenson, Los Alamos National Lab.

U.S. Patent and Trademark Office, U.S. Patent 6,959,248 B2, 25 Oct 2005

This patent describes a method and system of identifying individual aerosol particles in real time. Sample aerosol particles are compared against and identified with substantially matching known particle types by producing positive and negative test spectra of an individual aerosol particle using a bipolar single-particle mass spectrometer. Each test spectrum is

compared to spectra of the same respective polarity in a database of predetermined positive and negative spectra for known particle types. A set of substantially matching spectra is obtained. Finally, the identity of the individual aerosol particle is determined from a set of substantially matching spectra by determining a best-matching one of the known particles types having both a substantially matching positive spectrum and a substantially matching negative spectrum associated with the best-matching known particle type.

Refinery Demonstration of Optical Technologies for Measurement of Fugitive Emissions and for Leak Detection

Chambers, Allen and Mel Strosher, Alberta Research Council, Inc., Edmonton, AB.

Project No: CEM 9643-2006, 47 pp, 2006

The work reported in this document was conducted to demonstrate the application of optical technologies--differential absorption lidar (DIAL) and infrared imaging gas leak visualization technology--at a Canadian refinery to obtain direct measurements of fugitive emissions, analyze the refinery plume(s) for VOCs, improve reporting for air pollutants and gases released from refineries, and identify the potential for emissions reductions. Emission losses from the refinery were found to be significantly greater than were likely to be predicted by standard emissions estimation methods.

[http://www.arc.ab.ca/ARC-](http://www.arc.ab.ca/ARC-Admin/UploadedDocs/Final%20report%20for%20refinery%202005%20March%2032.pdf)

[Admin/UploadedDocs/Final%20report%20for%20refinery%202005%20March%2032.pdf](http://www.arc.ab.ca/ARC-Admin/UploadedDocs/Final%20report%20for%20refinery%202005%20March%2032.pdf)

Remote Inspection of a 46-Year-Old Buried High-Level Waste Storage Tank

Elder, J.B.

Practical Failure Analysis, Vol 3 No 3, p 49-56, June 2003

This paper describes remote ultrasonic examinations of a high-level radioactive waste storage tank at the Savannah River Site in South Carolina. The inspections were performed from the contaminated annular space of an inactive, 46-year-old waste storage tank with a capacity of 1.03 million gallons. A steerable magnetic-wheel wall crawler was inserted into the annular space through small (6-inch diameter) holes in the tank top. The crawler carried the equipment (up to four ultrasonic transducers and two cameras), which collected data simultaneously. The inspection was conducted to verify corrosion models and to investigate the possibility of previously unidentified corrosion sites or mechanisms. The inspections included evaluation of previously identified leak sites, thickness mapping, and crack detection scans on specified areas of the tank. No indications of reportable wall loss or pitting were detected. All thickness readings were above minimum design tank-wall thickness, though small indications of thinning were noted. The crack detection and sizing examinations revealed five previously undetected indications, four of which were only partially through-wall. The cracks were found to be slightly longer than expected but still well within the flaw size criteria used to evaluate tank structural integrity.

<http://www.osti.gov/dublincore/ecd/servlets/purl/810994-OG4HQT/native/810994.pdf>

Remote Sensing of SO₂ And NO₂ Emissions from Industrial Sources in Mexico by Passive DOAS

Basaldud, R. and M. Grutter, Univ. Nacional Autonoma de Mexico.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

Differential optical absorption spectroscopy (DOAS) is a remote sensing technique widely used in a variety of platforms and applications for studying trace gases in the atmosphere. A passive DOAS using scattered sunlight from the sky was used to observe and monitor the absorption of UV and visible light from SO₂ and NO₂, respectively, emitted by industrial sources. Column concentrations of these gases were measured while traversing underneath the plume in an automobile. Results are presented from measurements performed downwind of a large refinery, as well as analysis of the emissions from a power plant.

Resistivity Change During Transport of Heavy Metal in Sand

Fukue, M. (Tokai Univ., Shizuoka, Japan); T. Inoue; Y. Fujimori; K. Kita; T. Chida; A. Nishihara.

Journal Engineering Geology, Vol 85 No 1-2, May 2006

A resistivity cone technique was developed to monitor the transport of hazardous substances in soils. Resistivity change during transport of heavy metals--Pb, Zn, Cu, Ni--was measured using sandy soils and a resistivity cone. The penetration of heavy metal ions into the sandy soils causes a decrease in soil resistivity at the first stage. The decrease in the resistivity was dependent on the concentration of heavy metal ions; however, the continuous transport of heavy metal ions gradually increased the resistivity to a high value.

Results and Lessons Learned Interim Report: Altus AFB Site [a Detailed Investigation of Vapor Intrusion]

Environmental Security Technology Certification Program (ESTCP). 110 pp, July 2005

This interim report presents results for the evaluation of vapor intrusion processes in Building 418 at Altus Air Force Base (AFB) in Oklahoma, the first of three demonstration sites. The test building is a single-story, slab-on-grade office building underlain by a shallow dissolved chlorinated solvent groundwater plume. Approximately 150 ft long by 50 ft wide, the small size and non-industrial use of this building is comparable to that of large houses, small apartment buildings, and small office buildings. The primary objective of the study is to identify and validate the limited site investigation scope that provides the most accurate and reliable evaluation of vapor intrusion at corrective action sites. At the three demonstration sites, this objective will be met by (1) collecting a high density of data related to vapor intrusion at the test site, (2) analyzing the data to obtain a thorough understanding of the site vapor intrusion processes, and (3) evaluating subsets of the data to determine which subset would provide the most accurate indication of the actual vapor intrusion at the site in an investigation of refined scope. This report discusses sampling analysis procedures and results, data interpretation, preliminary conclusions, and lessons learned.

<http://docs.serdp-estcp.org/viewfile.cfm?Doc=ER%2D0423%2DIR%2D01%2Epdf>

The Retrieval of Oxygenated Volatile Organic Compounds by Remote Sensing Techniques
Wittrock, F., A. Heckel, H. Oetjen, A. Richter, and J.P. Burrows, Univ. of Bremen.
Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

Global measurements of formaldehyde and glyoxal trace gases derived from stray light spectra in the ultraviolet and visible wavelength region were measured by the satellite instrument SCIAMACHY and by ground-based MAXDOAS instruments. The analysis was carried out using differential optical absorption spectroscopy (DOAS). New algorithms to derive vertical columns of the satellite instruments are described. For the ground-based geometry, a method was found to derive profile information for the tropospheric absorbers. Case studies illustrate the significance of biogenic emissions and biomass burning for the global distribution of the oxygenated volatile organic compounds. A comparison with results from a global atmosphere model shows only a moderate agreement in many areas of the Earth, which reflects the limited state of present knowledge about the complex physical and chemical processes in the troposphere.

Retrieval of Profile Information from Airborne Multi Axis UV/Visible Skylight Absorption Measurements

Bruns, M., S.A. Buehler, and J.P. Burrows (Univ. of Bremen); K.-P. Heue, U. Platt, and I. Pundt (Univ. of Heidelberg); A. Richter; A. Rozanov; T. Wagner; P. Wang.
Applied Optics, Vol 43 No 22, p 4415-4426, 2004

A recent development in ground-based remote sensing of atmospheric constituents by UV/visible absorption measurements of scattered light allows the simultaneous use of several horizon viewing directions in addition to the traditional zenith-sky pointing. The different light paths through the atmosphere enable the vertical distribution of atmospheric absorbers--NO₂, BrO, or O₃--to be retrieved. This novel instrument, the Airborne MultiAXis Differential Optical Absorption Spectrometer, or AMAXDOAS, has been flown for the first time to study the amount of profile information that can be retrieved from such measurements. For trace NO₂, sensitivity studies on synthetic data were performed at two different flight altitudes for a variety of representative measurement conditions, including two wavelengths, one in the UV and one in the visible, two different surface spectral reflectances, and various lines of sight. The results demonstrate that the AMAXDOAS measurements contain useful profile information, mainly at flight altitude and below the aircraft. Depending on wavelength and line of sight used, the vertical resolution of the retrieved profiles is as good as 2 km near flight altitude. Above 14 km, the profile information content of AMAXDOAS measurements is sparse.

http://www.sat.uni-bremen.de/members/sab/publications/doas/doas_retrieval_paper.pdf

Scanning Eye-Safe Depolarization Lidar at 1.54 Microns and Potential Usefulness in Bioaerosol Plume Detection

Mayor, Shane D., Scott M. Spuler, and Bruce M. Morley, National Center for Atmospheric Research, Boulder, CO.

Lidar Remote Sensing for Environmental Monitoring VI, Proceedings of SPIE--The International Society for Optical Engineering, Vol 5887, 2005

A lidar that has the capacity for high signal-to-noise backscatter returns, fine spatial resolution, rapid updates, eye-safety at all ranges, and long-range operation is required for

effective monitoring of the atmosphere for potentially hazardous aerosol plumes in urban areas. A scanning elastic-backscatter lidar with high pulse energy that meets these requirements has been developed at the National Center for Atmospheric Research. System upgrades include the use of a new Raman cell for wavelength conversion and a 2-channel receiver for backscatter depolarization ratio measurements. Highlights from recent field tests of the system are presented, and plans for future improvements are discussed.

http://www.eol.ucar.edu/lidar/real/SPIE_REAL_depol_article.pdf

Scanning Eye-Safe Elastic Backscatter Lidar at 1.54 μm

Spuler, Scott M. and Shane D. Mayor, National Center for Atmospheric Research, Boulder, CO.

Journal of Atmospheric and Oceanic Technology, Vol 22, p 696-703, 2005

2-D spatial images were created by scanning with a field-deployable, scanning direct-detection, elastic-backscatter lidar 1.54- μm wavelength system. This eye-safe system has a useful range from approximately 500 m to several kilometers or more (depending on weather conditions) with 3-m range resolution. The images are ideal for locating sources of pollutants, tracking their dispersal, and elucidating structure in the cloud-free atmosphere. The data presented were collected in a populated area, which would not have been possible with a non-eye-safe system.

http://www.eol.ucar.edu/lidar/real/Spuler_and_Mayor_Scanning_REAL_JTECH.pdf

Screening GC/MS Data Files for 900 Environmental Contaminants in Less Than Three Minutes
Wylie, Philip L., Michael J. Szelewski, and Chin-Kai Meng, Agilent Technologies, Wilmington, DE.

The 231st ACS National Meeting, Atlanta, GA, March 26-30, 2006, ENVR 49.

This paper describes a database and software to screen GC/MS files for about 900 food and environmental contaminants, including pesticides, PCBs, PAHs, organophosphorus fire retardants, and suspected endocrine disruptors. The database contains mass spectra and expected retention times. To screen samples for these contaminants, normal GC/MS data analysis software has been combined with the automated mass spectral deconvolution and identification system (AMDIS) so that spectra can be deconvoluted before searching the target library. Retention time locking is used to filter hits on the basis of their "locked" retention times. Hits must satisfy the library matching criteria and have correct retention times. For additional validation, the deconvoluted spectra can be searched against the entire NIST mass spectral library. A single report is generated that combines the results from all three analyses.

Secondary Organic Aerosol Formation from Anthropogenic Air Pollution: Rapid and Higher than Expected

Volkamer, R. (Massachusetts Inst. of Technology, Cambridge), J.L. Jimenez, F. San Martini, K. Dzepina, Q. Zhang, D. Salcedo, L.T. Molina, D.R. Worsnop, and M.J. Molina.

Geophysical Research Letters, Vol 33, 2006

In the real urban atmosphere, reactive anthropogenic VOCs (AVOCs) produce much larger amounts of secondary organic aerosol (SOA) than state-of-the-art models predict, even shortly after sunrise. Contrary to current belief, a significant fraction of the excess SOA is

formed from first-generation AVOC oxidation products. In global models, AVOCs are a very minor contributor to SOA compared to biogenic VOCs (BVOCs). If the results are extrapolated to other urban areas, AVOCs could be responsible for additional 3 to 25 Tg/yr SOA production globally, and cause up to -0.1 W/m^2 additional top-of-the-atmosphere radiative cooling. The chemical transformation of SOA-precursor VOCs was studied in the Mexico City metropolitan area (MCMA) during the MCMA-2003 field campaign, using data collected at the CENICA supersite in the southeastern section of the MCMA. Direct measurements of glyoxal (CHOCHO) by open-path differential optical absorption spectroscopy (DOAS) had recently become possible, and two open-path DOAS instruments directly measured time-resolved concentrations of gas-phase CHOCHO and numerous aromatic SOA-precursor VOCs (among other species) with a time resolution of few minutes. Further quantitative measurements of the size-resolved aerosol chemical composition of fine particles were carried out by aerosol mass spectrometry (AMS) with a 4-minute time resolution.

http://cires.colorado.edu/jimenez/Papers/2006GL026899_published.pdf

Selective Fluorescence Determination of Chromium(VI) in Water Samples with Terbium Composite Nanoparticles

Wang, L., G. Biana, L. Donga, T. Xiaa, S. Honga, and H. Chena, Anhui Normal Univ., Wuhu, China.

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Vol 65 No 1, p 123-126, Sep 2006

Tb/acetyl acetone (acac)/poly(acrylamide) (PAM) composite nanoparticles exhibiting strong fluorescence have been prepared under ultrasonic radiation. The nanoparticles are water-soluble, stable and have extremely narrow emission bands and high internal quantum efficiencies. Based on fluorescence quenching of Tb/acac/PAM by Cr(VI), a method for the selective determination of Cr(VI), without separation of Cr(III) in water, has been developed. The proposed method is characterized by short reaction time, little interference, stable fluorescence signals, and simplicity. It has been applied to the selective quantification of Cr(VI) in synthetic samples and wastewater samples with satisfactory results.

Sequestration and Bioavailability of Hydrophobic Chemicals in Sediment

Kraaij, Rik, Ph.D. dissertation, University of Utrecht, 105 pp, 2001

In the research presented in this thesis, deeper understanding of the interaction of processes that determine bioavailability of hydrophobic organic contaminants (HOCs) to bottom feeders was sought. A refined model for the estimation of the biota to sediment accumulation factor (BSAF) was developed. The investigation examined whether rapidly desorbing fractions were related to bioavailability to bottom feeders (Chapter 2, 3) and studied the causality between the two (Chapter 4) with the goal of understanding basic processes leading to bioaccumulation. The research also attempted to unravel the relationship between rapidly desorbing fractions and bioaccumulation by investigating the distribution of HOCs between rapidly desorbing sediment compartment, porewater, and organisms. A recently developed technique was applied to measure freely dissolved concentrations of HOCs in the porewater (Chapter 5).

<http://igitur-archive.library.uu.nl/dissertations/1960191/inhoud.htm>

Shock Resistant Electronic Nose Microsystem Applied in a Percussion Driller for On-Site and On-Line Depth-Profiling of Soil Pollutants

Goschnick, J.A., C. Arnold, and D. Haringer, Forschungszentrum Karlsruhe.

PITTCON 2006: 57th Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Orlando, FL, 12-17 March 2006.

A compact electronic nose package has been developed that withstands extreme mechanical loads as well as high temperatures, the stress factors often impeding chemical monitoring. A battery-powered cylindrical EN module based on the Karlsruhe Micronose (KAMINA) was set up and integrated into a standard percussion driller soil probe for rapid depth-resolved screening of volatile pollutants. A 3.5 x 3mm²-gradient microarray chip is equipped with a Pt-doped sputtered SnO₂-film subdivided into 16 gas sensor segments differentiated in their sensing properties by a temperature and a thickness gradient of a gas permeable SiO₂-coating with a few nm variation across the array. The chip package and the electronics are fixed with dampers inside a cladding tube. Excellent detection limits (<10mg/m³) were obtained for most soil pollutants in continuous analysis with 1-second resolution. A hierarchical linear discriminant analysis of the signal patterns has been developed to classify the pollutants. Measuring campaigns with a KAMINA-equipped percussion driller were performed in test sand beds using an electric hammer with 1,400 hits/min for ground penetration. The tubular KAMINA module survived the hammering action without damage while successfully recording depth profiles of aromatic and chlorohydrocarbons at a depth range of a few meters.

Silicon Carbide Micro-Devices for Combustion Gas Sensing under Harsh Conditions

Ghosh, R.N. and R. Loloee (Michigan State Univ.); R.G. Tobin and Y.H. Kahng (Tufts Univ.). U.S. DOE, Office of Scientific and Technical Information, 49 pp, Apr 2006

A sensor based on the wide bandgap semiconductor, silicon carbide (SiC), has been developed for the detection of combustion products in power plant environments. The sensor is a catalytic gate field effect device that can detect hydrogen-containing species in chemically reactive, high-temperature environments. For fast and stable sensor response measurements, a gate activation process is required. Activation of all sensors takes place by switching back and forth between oxidizing (1.0 % oxygen in nitrogen) and reducing (10 % hydrogen in nitrogen) gases for several hours at a sensor temperature ≥ 620 °C. All 52 devices on the sensor chip are activated simultaneously by flooding the entire chip with gas. The effects of activation on surface morphology and structure of Pt gates before and after activation were investigated. The optical images obtained from Pt gates demonstrated a clear transition from a smooth and shiny surface to a grainy and cloudy surface morphology. XRD scans collected from Pt gates suggest the presence of an amorphous layer and species other than Pt (111) after activation. In an examination of the reliability of the gate insulator of the metal-oxide-SiC sensors for long-term device operation at 630 degrees C, the dielectric was stable against breakdown due to electron injection from the substrate with gate leakage current densities as low as 5nA/cm² at 630 degrees C. A new nano-reactor was designed and constructed that is capable of high gas flow rates at elevated pressure. The reactor, which is a miniature version of an industrial reactor, is designed to heat the flowing gas up to 700 degrees C. Measurements in ultrahigh vacuum demonstrated that hydrogen sulfide readily deposits sulfur on the gate surface, even at the very high hydrogen/hydrogen sulfide ratios (103 - 105) expected in applications. Once deposited, the sulfur

adversely affected sensor response, and could not be removed by exposure to hydrogen at the temperatures and pressures accessible in the ultrahigh vacuum experiments. Oxygen exposures, however, were very effective at removing sulfur, and the device performance after sulfur removal was indistinguishable from performance before exposure to H₂S.

<http://www.osti.gov/bridge/servlets/purl/882583-fTxqBm/882583.PDF>

Silicon Microelectrode Arrays for In Situ Environmental Monitoring

Wei, Xingtao, Master's thesis, University of Cincinnati, 67 pp, 2005

Silicon microelectrode arrays for in situ environmental monitoring have been successfully developed in this work. Meniscus etching was used to sharpen these cantilevered probes. Microelectrodes with solid tips were fabricated for oxidation-reduction potential (ORP) measurements. Microelectrodes with recessed tips were fabricated for future developments of ion selective electrodes. Both microelectrode types were fully characterized with standard and reference solutions as recommended by ASTM (American Society for Testing and Materials). The silicon microelectrodes have substantially smaller sensing areas (μm vs. cm) than their current commercial counterparts and exhibit significantly faster response times (milliseconds vs. minutes). The sensors are robust due to redundant array configuration and the material strength of silicon. In the long term, the use of these new sensors is envisioned for the in situ monitoring of groundwater quality and bioremediation applications.

http://www.ohiolink.edu/etd/view.cgi?acc_num=ucin1123783607

Silver Halide Fiber-Based Evanescent-Wave Liquid Droplet Sensing with Room Temperature Midinfrared Quantum Cascade Lasers

Chen, J.Z., Z. Liu, and C.F. Gmachl (Princeton Univ., NJ); D.L. Sivco (Lucent Technologies). Optics Express, Vol 13 No 16, p 5953-5960, 8 Aug 2005

Quantum cascade lasers and unclad silver halide fibers were used to assemble mid-infrared fiber-optics evanescent-wave sensors suitable to measure the chemical composition of liquid droplets. The laser wavelengths were chosen to be in the regions that offer the largest absorption contrast between constituents inside the mixture droplets. The study was conducted as a precursor for a miniature integrated sensor system using QCLs and evanescent waveguide sensing. The sensitivity and detection limit can be further improved with a planar waveguide of thickness on the order of the laser wavelength, i.e., reaching the leaky waveguide limit.

http://www.opticsexpress.org/DirectPDFAccess/CC4E7B21-BDB9-137E-CBAE692AD438CF24_5953.pdf?da=1&id=85254&seq=0&CFID=31315978&CFTOKEN=64988114

A Simple, Inexpensive and Large Volume Pore Water Sampler for Sandy and Muddy Substrates

Nayar, S., D. Miller, S. Bryars, and A.C. Cheshire, South Australian Research and Development Institute, West Beach, SA, Australia.

Estuarine, Coastal and Shelf Science, Vol 66, p 298-302, 2006

This paper describes the construction and testing of a simple, low-cost intertidal and sub-tidal porewater sampler for use in sandy and muddy substrates. The "poreextractor" sampler is made of readily available polyvinyl chloride (PVC) plumbing materials. The only mechanical

component is a plunger that is used only once, at the time of deployment. The poreextractor was designed for use on seagrass beds to collect porewater samples with minimal disturbance to the substratum for nutrient flux studies. The relative efficiency of the poreextractor was tested against the widely used Winger & Lasier sampler, a vacuum-operated diffuser stone porewater sampler. The two samplers were compared for the volume of porewater collected in sandy and muddy substrates in the laboratory, as well as the concentrations of total nitrogen and total phosphorus in samples collected from a sandy substrate in seagrass meadows. While the poreextractor and the Winger & Lasier samplers worked equally well in the sandy sediments, the poreextractor was more efficient than the latter in muddy sediments, where clogging was a major problem. No significant differences were observed in the concentrations of total nitrogen and total phosphorus measured from the porewater samples collected by the two samplers in situ from the seagrass bed.

http://www.sardi.sa.gov.au/pdfserve/aquatic/pub/mee/eamr/porewater_samp.pdf

Simultaneous Measurements of Atmospheric Pollutants and Visibility with a Long-Path DOAS System in Urban Areas

Lee, J.S. (Kwangju Inst. of Science and Technology, Gwangju, Korea), Y.J. Kim, B. Kuk, A. Geyer, and U. Platt.

Environmental Monitoring and Assessment, Vol 104 Nos 1-3, p 281-293, May 2005

The applicability of a long-path differential optical absorption spectroscopy (LP-DOAS) system was investigated for the feasibility of simultaneous measurement of trace gases (e.g., O₃, NO₂, SO₂, and HCHO) and atmospheric visibility (light extinction by aerosols) in urban areas. The LP-DOAS system can simultaneously measure key air pollutants at detection limits in the ppb/sub-ppb range as well as the Mie extinction coefficient with an uncertainty of approximately 0.1/km at time resolution of a few minutes.

Simultaneous Measurement of Vaporous and Aerosolized Threats by Active Open Path FTIR
Hashmonay, R.A., R.M. Varma, M. Modrak, and R.H. Kagann (ARCADIS, Durham, NC); P.D. Sullivan (Air Force Research Laboratory, Tyndall AFB, FL). 2004 Scientific Conference on Chemical and Biological Defense Research, 15-17 November 2004, Hunt Valley, Maryland.
NTIS: ADA449529, 14 pp, Nov 2004

U.S. EPA's open-path Fourier transform infrared (OP-FTIR) activities include passive and active measurements in several stack and fugitive emission monitoring applications. Extensive research has been devoted in recent years to evaluate and validate various OP-FTIR technologies for the identification and detection of toxic industrial compounds and chemical warfare agents, primarily in the gas phase. This paper emphasizes the superiority of the active OP-FTIR system over the passive system in detection levels and data quality, and disputes misconceptions that are generally well-accepted for FTIR technologies. Additionally, a new approach for detection and identification of aerosolized threats using an active modulated OP-FTIR is described. Revisiting the use of active OP-FTIR techniques is recommended, as many non-battlefield detection applications have emerged recently.

<http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=ADA449529&Location=U2&doc=GetTRDoc.pdf>

Simultaneous Measurement of Ventilation Using Tracer Gas Techniques and VOC Concentrations in Homes, Garages and Vehicles

Batterman, S., C. Jia, G. Hatzivasilis, and C. Godwin.

Journal of Environmental Monitoring, Vol 8, 249-256, 2006

This paper presents the development of an updated approach to measure air exchange rates and interzonal flows using perfluorocarbon tracer (PFT) gases, the constant injection-rate method, and adsorbent-based sampling of PFT concentrations. Simultaneous deployment of sources and passive samplers will not cause significant errors over multiday measurement periods in buildings. Tracer measurement over periods of hours to a week can be accomplished using active or passive samplers, and low method detection limits and high precision are easily achieved. The method obtains the effective air exchange rate (AER), which is relevant to characterizing long-term exposures, especially when ventilation rates are time-varying. Concentrations of other VOCs can be determined simultaneously with those of the PFT tracers. Pilot tests of the method were conducted in three environments, a residence, garage, and vehicle cabin. The method is versatile in that it simultaneously determines AERs, interzonal flows, and VOC concentrations over long and representative test periods. Also described is the design of miniature PFT sources using hexafluorotoluene and octafluorobenzene tracers, and the development and validation of an analytical GC/MS method for these tracers.

Smart Leak Detection and Repair (LDAR) for Control of Fugitive Emissions

American Petroleum Institute, June 2004

This report presents technology background and test results on an improved leak detection and control method for application in refineries and petrochemical plants. Smart leak detection and repair (LDAR) focuses on locating and repairing the most significant leaking components, cheaper and more quickly than existing LDAR practices. A 1997 study of 11.5 million refinery components showed that over 90% of all controllable fugitive emissions from refineries are from about 0.1% of all components. This result and statistical analyses show that a Smart LDAR program that focuses on finding and repairing this minority of high "leakers" could result in an improvement in environmental performance. Emerging optical imaging technologies enable adoption of a Smart LDAR program that targets significant leakers. Remote sensing and instantaneous detection capabilities of optical imaging technologies allow an operator to scan process areas containing tens to hundreds of potential leaks. The area being viewed is illuminated with infrared light that allows an image of chemical leaks to be viewed live. Significant leaks are identified immediately, allowing quicker repair, and ensuring efficient use of resources. Section I contains studies investigating an alternative (backscatter absorption gas imaging (BAGI) infrared laser technology) to current Method 21, and section II covers laboratory and field testing of optical imaging technologies.

Soil Biological Activities in Monitoring the Bioremediation of Diesel Oil-Contaminated Soil

Riffaldi, R. (Univ. di Pisa, Pisa, Italy); R. Levi-Minzi; R. Cardelli; S. Palumbo; A. Saviozzi.

Water, Air, and Soil Pollution, Vol 170 No 1-4, p 3-15, Feb 2006

The effects of two different biological treatments on hydrocarbon degradation and on soil biological activities were determined during a 100-day incubation period. An evaluation of soil biological activities as a monitoring instrument for the decontamination process of diesel-oil

contaminated soil was made using measurements of organic carbon content, soil microbial respiration, soil ATP and dehydrogenase, beta-glucosidase, lipase enzyme activities. The relationships between soil parameters and the levels of total petroleum hydrocarbons residues were investigated. The residual hydrocarbon trend was found to be positively related to the organic C content, microbial respiration, and beta-glucosidase activity, while both soil lipase and dehydrogenase activities were negatively related to the hydrocarbon trend. Lipase activity was found to be the most useful parameter for testing hydrocarbon degradation in soil.

Sources of Groundwater Nitrate Revealed Using Residence Time and Isotope Methods
Moore, K.B. and B. Ekwurzel (Univ. of Arizona, Tucson); B.K. Esser, G.B. Hudson, and J.E. Moran (Lawrence Livermore National Laboratory, Livermore, CA).
Applied Geochemistry, Vol 21 No 6, p 1016-1029, June 2006

Nitrate isotope data are effective in determining contaminant sources, especially when combined with other isotopic tracers such as stable isotopes of water and ^3H -He ages to give insight into the routes and timing of NO_3 inputs to the flow system. This combination of techniques is demonstrated in Livermore, CA, where it is determined that low NO_3 reclaimed wastewater predominates in the NW, while two flowpaths with distinct NO_3 sources originate in the SE. An analysis of results is provided.

Sorption of Trace Metals by Standard and Micro Suction Cups in the Absence and Presence of Dissolved Organic Carbon

Rais, D. (Swiss Federal Inst. for Forest, Snow and Landscape Research); B. Nowack and R. Schulin (Swiss Federal Inst. of Technology); J. Luster (Swiss Federal Inst. for Forest, Snow and Landscape Research).

Journal of Environmental Quality, Vol 35 No , p 50-60, 2006

Metal sorption by different materials used in suction cups for sampling trace metals in soil can vary widely, depending also on the chemistry of the soil solution. The sorption of Cu, Zn, Cd, and Pb by different standard-size and micro-suction cups was compared in the laboratory at two pH values (4.5 and 7.5 or 8.0) in the absence and presence of dissolved organic carbon (DOC). At both pH values, the weakest sorption of all four trace metals was displayed by standard-size suction cups based on nylon membranes and by hollow fibers made from polyvinyl alcohol (PVA). At alkaline pH, borosilicate glass, ceramic materials, and polytetrafluorethylene (PTFE) mixed with silicate exhibited generally strong sorption of all investigated trace metals. Cu and Pb were strongly sorbed at low pH by PTFE/silicate and a ceramic material used for the construction of standard-size suction cups, whereas sorption of Cu, Zn, and Cd by ceramic capillaries produced from pure aluminum oxide was negligible at low pH. Micro-suction cups made of an unknown polymeric tube sorbed Cu strongly, but were well suited to monitor Zn, Cd, and Pb at low pH and, in the presence of DOC, at high pH. Major cations (Na^+ , Mg^{2+} , K^+ , Ca^{2+}) and anions (Cl^- , NO_3^- , SO_4^{2-}) were not or were very weakly sorbed by all cup materials, except for Mg^{2+} , K^+ , and Ca^{2+} by borosilicate glass at pH 7.5. Trace metal sorption by suction cups was generally greatly reduced in the presence of DOC, especially at alkaline pH.
<http://www.ito.ethz.ch/SoilProt/staff/nowack/publications.html>

Sorption to Soil of Hydrophobic and Ionic Organic Compounds: Measurement and Modeling
ter Laak, Thomas Laurens, Ph.D. dissertation, University of Utrecht, The Netherlands, 163 pp,
2005

Soil sorption of various organic compounds was studied to improve the scientific basis for representing sorption in risk assessment. Chapters 2 to 5 examine the sorption of hydrophobic organic chemicals, focusing on the development and validation of passive sampling techniques to simplify the determination of freely dissolved concentrations and sorption coefficients. Chapters 6 and 7 explore the sorption of ionizable organic antimicrobial agents in relation to the porewater and soil composition. Difficult determination of freely dissolved concentrations and the heterogeneity of soil organic material can complicate the measurement and modeling of sorption coefficients for neutral organic (hydrophobic) compounds. A simple and sensitive solid-phase microextraction (SPME) technique using a poly-dimethylsiloxane (PDMS) coated fiber was employed in this work. This passive sampling technique can measure (changes in) freely dissolved concentrations in complex matrices such as soil (Chapter 4 and 5), sediment (Chapter 3) and dissolved organic matter solutions (Chapter 2), and should therefore be applied to generate unbiased sorption coefficients. The simplicity and sensitivity of the technique strongly advocates for both generating high quality sorption data for modeling purposes and specific monitoring and risk assessment of contaminated sites. Because there is only limited knowledge on the soil sorption of polar ionizable organic compounds, such as veterinary pharmaceuticals, more research is needed on the sorption of these compounds. This work has demonstrated that soil properties like organic carbon content, clay content, cation exchange capacity, and iron and aluminum oxyhydroxide content (Chapter 7), and porewater properties like pH and ionic strength (Chapter 6) significantly influence sorption of these compounds. Modeling the influence of soil properties allows prediction of sorption with limited accuracy. Modeled sorption data should therefore (only) be taken as qualitative indicators of the sorption behavior. Consequently, experimental data are preferred for site-specific risk assessment.

<http://igitur-archive.library.uu.nl/dissertations/2006-0529-200329/index.htm>

Space-Resolved Open-Path Detection of Trace Gases by Mid IR Quantum Cascade Laser
Taslakov, M., V. Simeonov, and H. Van den Bergh, Federal Inst. of Technology, Lausanne,
Switzerland.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006

In space-resolved detection of trace gases over a long-trajectory open path by a pulsed quantum cascade laser (QCL), the gas concentration is retrieved from mid-IR absorption spectra by a two-wavelength differential absorption technique. The spectra are taken by fast, repetitive wavelength sweeping. The wavelength chirp during the excitation pulse is used for wavelength tuning. Tuning ranges of up to 1 cm⁻¹ for sweeping times of 200 ns have been achieved. Short tuning times prevent line distortions caused by atmospheric turbulence. The experimenters adopted a "monostatic" (transmitter-retroreflector-receiver). Spatial resolution was achieved by placing a number of retroreflectors along the optical path. Because of the use of a pulsed QCL, a profile with minimal spatial resolution $\Delta L = cT/2$ can be acquired, where T is the pulse durations and c the speed of light. In a demonstration of the principle, two retroreflectors were placed 220 and 2900 m from the laboratory. The retroreflector effective apertures and spatial locations were chosen to get similar signal levels. The experiments were carried out in the 8-13 μ m atmospheric window to minimize water and CO₂ influence. Ozone and CO₂ were measured

simultaneously using a single laser with a characteristic wavenumber 1031 cm^{-1} . The lower cross section of water in this spectral region allowed long-path observations of water vapor. The proposed method allows the measurement of horizontal profiles of atmospheric compounds absorbing in the near- and mid-IR spectral ranges, with potential application in meteorology, atmospheric chemistry, and environmental studies.

Spatially Resolved DOAS Measurements of Trace Gases and Aerosol

Platt, Ulrich, Univ. of Heidelberg, Germany.

Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

DOAS techniques have been developed and tested in the last few years that allow spatially resolved measurements of trace gases or the aerosol optical density, including active-DOAS tomographic measurements of 2-D trace gas distributions, passive-DOAS tomographic measurements of 2-D trace gas distributions using topographic targets light scattering (ToTal-DOAS), observation of vertical distributions of gases and aerosols with multi-axis DOAS (airborne and ground-based), and imaging DOAS observation of trace gas column densities. These DOAS variants provide data for initialization and validation of multi-dimensional chemistry-transport models. Common features of the techniques, associated evaluation procedures, hardware requirements, and novel scientific applications of the new techniques are discussed.

Spectroscopic Remote Sensing of Volcanic Gases: The Ecuadorian Case

Arellano, S., M. Hall, and E. Ayala, Escuela Politecnica Nacional, Quito, Ecuador.

Optica Pura Y Aplicada, Vol 39 No 1, 2006

Recent advances in spectroscopy, the emerging of new materials and the increased capabilities of computers have allowed the development and implementation of many gas monitoring techniques such as correlation spectroscopy (COSPEC), differential optical absorption spectroscopy (DOAS), and fourier transform infrared spectroscopy (FTIR). These techniques have been used successfully in Ecuador for the remote sensing of emissions from Ecuadorian volcanoes.

<http://www.sedoptica.es/revistas/pdfs/190.pdf>

Specular Reflection and Diffuse Reflectance Spectroscopy of Soils

Reeves, James B.; Barry A. Francis; Stephen K. Hamilton.

Applied Spectroscopy, Vol 59 No 1, p 39-46, Jan 2005

Mid- and near-infrared spectroscopy utilize light in regions beyond human sight to determine the composition of materials such as soils. With powders, diffuse reflectance can be used where the light diffuses into the sample and is then reflected back to a detector for quantification. If the light simply reflects from the surface without penetrating the sample, this is called specular reflection and can cause various distortions in the spectrum, e.g., the spectrum changes in a non-uniform fashion with concentration. This is an effect often seen with mid-infrared spectra, but not with near-infrared spectra. In this work, it has been found that distortions in mid-infrared spectra due to specular reflection occur for both organic (humic acid) and non-organic fractions (carbonates, silica, ashed fraction of soil). The results explain why the

spectrum of calcium carbonate in limed soils did not match that of published spectra and offer an explanation as to why the presence of inorganic-C interferes with the development of mid-infrared calibrations for organic-C in soil, but not for near-infrared calibrations. These results may also have far-reaching implications for the use of mid-infrared spectra for quantitative and qualitative analysis of soils. For example, commercial libraries of spectra collected by means other than diffuse reflectance would be largely useless for comparing mineral spectra to soil spectra. Also, the results discussed here may indicate that at least for some soil types (e.g., large differences in mineralogy or C content), separate calibrations or the use of non-linear calibrations methods will be necessary.

Stimuli-Responsive Disassembly of Nanoparticle Aggregates for Light-Up Colorimetric Sensing
Liu, Juewen and Yi Lu, Univ. of Illinois, Urbana-Champaign.
Journal of the American Chemical Society, Vol 127, p 12677-12683, 2005

Controlled disassembly of nanomaterials has not received much attention, though both controlled assembly and disassembly are important in biology. By using a Pb^{2+} -dependent RNA-cleaving DNAzyme, the authors demonstrated control of the disassembly of gold nanoparticle aggregates in response to Pb^{2+} . Nanoparticle alignment played an important role in the disassembly process, with the tail-to-tail configuration being the most optimal, probably because of the large steric hindrance of other configurations. The rate of disassembly is significantly accelerated by using small pieces of DNA to invade the cleaved substrate of the DNAzyme. Investigation of such a controlled disassembly process allows the transformation of previously designed "light-down" colorimetric Pb^{2+} sensors into "light-up" sensors.

<http://montypython.scs.uiuc.edu/paper.htm>

Studies on a New Fluorescence Immunoassay for Determination of 2,4,6-Trichlorophenol in the Environmental Water

Zhuang, H., Y. Yu, and Q. Wang, DongHua Univ., Shanghai, China.

The 231st ACS National Meeting, Atlanta, GA, March 26-30, 2006, ENVR 193

A fast and reliable immunomethod has been developed to determine a trace amount of 2,4,6-trichlorophenol (2,4,6-TCP) in aqueous samples. The method is based on an indirect fluoroimmunoassay (FIA) format. A hapten (i.e., a small molecule that is not immunogenic unless attached to a carrier protein) of 2,4,6-TCP was synthesized by reaction of this compound with chloroacetic acid under a basic condition. The hapten was conjugated to bovine serum albumin (BSA) with the modified active ester method to form an artificial immune antigen (TCP-BSA). The anti-TCP polyclonal antibodies were obtained by using the artificial immune antigen to immune in the rabbits. Using the purified antiserum with the highest specificity, an antibody-coated FIA was developed with a detection limit of 0.25 $\mu\text{g/L}$. The antibody shows very little cross-reactivity with other phenols, and the method has been successfully applied to detect 2,4,6-TCP in environmental water.

Sub-Surface Probe Module Equipped with the Karlsruhe Micronose KAMINA Using a Hierarchical LDA for the Recognition of Volatile Soil Pollutants

Arnold, C., D. Haeringer, I. Kiselev, and J. Goschnick, Forschungszentrum Karlsruhe, Karlsruhe, Germany.

Sensors and Actuators B: Chemical, Vol 116 Nos 1-2, p 90-94, 28 July 2006

A battery-operated cylindrical EN module was developed for integration in an electric hammer-driven soil air probe for rapid depth-resolved soil screening. KAMINA, the Karlsruhe Micronose, is combined as a 3.5 mm x 3 mm gradient microarray chip in the EN module with the complete battery-operated electronics and a single Pt-doped SnO₂-film. The microarray chip is fixed with only bond wires within the clearance of a ceramic carrier card, thus achieving high mechanical stability and low power consumption. Test exposures of the module were carried out with chlorinated, aromatic, and aliphatic hydrocarbon soil contaminants to investigate KAMINA's gas analytical performance. The detection limits were less than 1 mg/m³ for aromatic and aliphatic hydrocarbons, and 10 to 500 mg/m³ for chlorinated hydrocarbons at response times of less than 100 seconds.

Surface Acoustic Wave (SAW) Microsensor Array for Measuring VOCs in Drinking Water

Groves, W.A., A.B. Grey, and P.T. O'Shaughnessy.

Journal of Environmental Monitoring, Vol 8, p 932-941, 2006

The laboratory development and evaluation of an instrument for field analysis of VOCs in drinking water is presented. The instrument is based on an array of six polymer-coated surface-acoustic-wave microsensors. Dichloromethane, chloroform, 1,1,1-trichloroethane, perchloroethylene, and m-xylene were used in a series of experiments designed to optimize the purge/trap preconcentration system, calibrate the instrument over the concentration range of 0.2 to 2 times the U.S. EPA maximum contaminant levels, and compare results to those of a reference laboratory. The primary goal was to develop a cost-effective alternative for on-site evaluation of VOCs in water. Calibration and evaluation test results for spiked water samples demonstrate adequate sensitivity for 19 of the 21 regulated VOCs considered using a ten minute sampling and analysis cycle.

Survey and Demonstration of Monitoring Technology for Houston Industrial Emissions (Project H31.2004)

ENVIRON International Corporation, Mountain View, CA.

Houston Advanced Research Center, 8 pp, Jan 2005

In August and September 2000, an intensive field study, called the Texas Air Quality Study (TexAQS), was conducted in the Houston-Galveston area (HGA) to study ozone and other air pollution issues in that region. Aerial surveys of chemical species in the atmosphere above the HGA showed higher ozone and ozone-precursor concentrations than would be expected from the emission inventory of volatile organic compounds (VOCs). The findings resulting from the TexAQS study prompted the evaluation of novel approaches to identify and control sources of air pollution. One such approach is the use of optical gas-imaging devices to identify emissions resulting from leaks in refinery and chemical plant process equipment, which have historically represented a large percentage of the VOC and hazardous air pollutant emissions from these facilities. Two studies recently conducted in Texas successfully demonstrated that gas-imaging

devices offer an operator the ability to monitor process equipment from a distance and to identify--in some cases instantaneously--leaking components (of a sufficient mass) within the line of sight of the optical imager. The remote sensing and instantaneous detection capabilities of optical gas-imaging technologies allow an operator to scan areas containing tens to hundreds of potential leaks, thus eliminating the need to visit and manually measure all potential leak sites. As a follow-up to the above referenced studies demonstrating the effectiveness of gas-imaging devices for identifying equipment leaks, a project was undertaken to identify, assess, and demonstrate cost-effective monitoring systems and technology to measure integrated (as opposed to process-specific) emissions profiles.

<http://files.harc.edu/Projects/AirQuality/Projects/H031.2004/Phase1A/H311AProjectSummary.pdf>

Syndiotactic Polystyrene Thin Film as Sensitive Layer for an Optoelectronic Chemical Sensing Device

Giordano, M. and M. Russo (National Research Council, Naples, Italy); A. Cusano (Univ. of Sannio); G. Mensitieri (Univ. of Naples); G. Guerra (Univ. of Salerno).

Sensors and Actuators B: Chemical, Vol 109 No 2, p 766-771, 13 May 2005

This paper describes the analysis of the performance of an optoelectronic sensor system developed to measure the concentration of organic analytes (e.g., chloroform and toluene) in aqueous environments.

Synthetic and Field Based Electrical Imaging of a Zerovalent Iron Barrier: Implications for Monitoring Long-Term Barrier Performance

Slater, L. and A. Binley.

Geophysics, Vol 71 No 5, p B129-B137, Sep/Oct 2006

A study was performed of electrical imaging sensitivity to geochemical alteration of a zero-valent iron permeable reactive barrier (PRB) over time. Complex resistivity measurements of laboratory cores from an operational PRB defined the electrical properties of both unreacted and geochemically altered reacted iron, as well as the growth rate of the reacted front on the upgradient edge of the barrier. Synthetic results show that although the internal structure of inverted images at 15 and 30 years does not accurately reflect the width of the reacted front modeled along the upgradient edge of the barrier, changes to the internal structure of the imaged PRB are indicative of the growth of the reacted front. Cross-borehole electrical data, obtained at the field site during a 15-month period, show that the complex-resistivity algorithm can resolve reliably the PRB target using the engineering design specifications to define the correct shape of the regularization disconnect. Both resistivity and induced-polarization reciprocal errors are low, and the induced-polarization data are highly repeatable over this period. Changes in the electrical properties of the PRB over time were small but consistent with growth of a reacted front, based on the synthetic study. Resistivity imaging alone may be sufficient for long-term monitoring of precipitation, which leads to reduced PRB performance.

<http://www.andromeda.rutgers.edu/~geology/Faculty/Slater/Slater%20and%20Binley%202006.pdf>

A System for Testing of Microelectrode Sensors

Das, Angan, Master's thesis, University of Cincinnati, 79 pp, 2005

The University of Cincinnati Microelectrode Research group has been working on the development of a portable, integrated microelectrode sensor system consisting of a printed circuit board that mounts a microelectrode sensor array and a sensor chip. The main specifications of the system are its high precision, portability, low power consumption, and minimal effects of noise. The sensor uses the principle of potentiometric measurement and amperometric measurement to sense the potential and current produced across the sensor array placed in the solution under test. The test results indicate that the signals produced vary in a monotonic fashion with the changing conditions of the solution.

http://www.ohiolink.edu/etd/view.cgi?acc_num=ucin1135716054

TCLP Investigations: the Development of a Rapid Screening Field Assessment Test

Jeppson, J., J. F. Ranville, and T. R. Wildeman, Colorado School of Mines, Golden.

10th Billings Land Reclamation Symposium--Reclamation: Supporting Future Generations, 4-8 June 2006. BLRS and ASMR, Lexington, KY. p 43, 2006

The Toxicity Characteristic Leaching Procedure (TCLP), EPA Method 1311, is commonly used to determine the potentially leachable metal concentrations in mine waste piles. This test takes a considerable sample amount (> 100 grams) and period of time (> 18 hours), which slows down initial assessment and thus hinders the remediation process. A Citizen's TCLP is proposed as a modified version of the EPA TCLP. The proposed method uses everyday compounds such as baking soda, vinegar, and bottled water. The test also uses volumetric measurements to eliminate the need for weighing in the field. Three different amounts of sediment--1, 2, and 3 teaspoons--are tested, and leachate samples are taken at 1-, 2-, and 3-hour intervals during the field TCLP. By varying the sediment:solution ratio and the reaction time, an approximation of the standard TCLP should be approached. Mining-impacted sediments and samples collected from New Orleans following Hurricane Katrina are being used in the development of this leach test. Further work is needed to determine the correct sediment:solution ratio and the length of reaction time. This scaled-down version of the TCLP may provide a rapid screening assessment tool that will speed up remediation decisions, with results obtained in hours instead of weeks.

Technical Standard for Water-Table Monitoring of Potential Wetland Sites

U. S. Army Corps of Engineers, U.S. Army Research and Development Center, Vicksburg, MS. ERDC TN-WRAP-05-02, 18 pp, June 2005

Wetland determinations in the majority of cases are based on the presence of readily observable field indicators of hydrophytic vegetation, hydric soils, and wetland hydrology, according to procedures given in the 1987 Corps of Engineers "Wetlands Delineation Manual." These three characteristics are the best available evidence that an area has performed in the past, and continues to perform, the functions associated with wetland ecosystems. Wetland determinations on some sites can be difficult because of human disturbance that has altered or destroyed wetland indicators. In addition, some naturally occurring wetland types may lack indicators or may have indicators present only at certain times of year or during certain years in a multi-year cycle. Wetland determinations in these atypical and problem situations may involve

the use of direct hydrologic monitoring to confirm the presence of wetlands. This technical note describes national standards for the collection, analysis, interpretation, and reporting of hydrologic data.

<http://el.erdc.usace.army.mil/wrap/pdf/tnwrap05-2.pdf>

The TESS-1 Suction Corer: a New Device to Extract Wet, Uncompacted Sediments

Mendez, G. and M. Perez-Arlucea (Univ. de Vigo, Vigo, Spain); E. Stouthamer and H. Berendsen (Utrecht Univ., The Netherlands).

Journal of Sedimentary Research, Vol 73 No 6, p 1078-1081, Nov 2003

The original purposes of the existing Van der Staay suction corer were to enable rapid drilling through sand and to allow field sampling. It was not designed to recover intact samples for subsequent laboratory analysis. Cores from the new TESS-1 suction corer, however, are encapsulated in the field. The TESS-1 combines the advantages of the original corer with the potential for taking samples for laboratory analysis. Samples collected using the TESS-1 suction corer show little deformation and allow coring of soft uncompacted mud and retention of sedimentary structures. The TESS-1 suction corer can be used in both wetland areas (beach, tidal flats, and marshes) and in shallow subaqueous environments (lakes, rivers, and nearshore subtidal areas).

Three Generations of Raman-Shifted Eye-Safe Aerosol Lidars

Mayor, S.D., S.M. Spuler, and B.M. Morley.

7th International Symposium on Tropospheric Profiling, 11-17 June 2006, Boulder, CO.

Extended Abstracts, p 8.33-8.34, Poster 8.22-P, 2006

Raman-shifted Eye-safe Aerosol Lidar (REAL) is a scanning elastic backscatter lidar that operates at 1.54 microns wavelength. This wavelength lies within a band that is the safest in the entire optical spectrum. REAL version 1 is a field-deployable prototype, while version 2 allows unattended and continuous operation from a permanent site. Version 3 has achieved longer range and faster scans and features narrow linewidth for the spectral separation of molecular and aerosol backscatter for calibration purposes.

http://www.eol.ucar.edu/lidar/8_22P_Mayor_etal.pdf

Trace Gas Detection with Antimonide-Based Quantum-Well Diode Lasers

Vicet A. (UMR CNRS-Univ. Montpellier, France); D.A. Yarekha; A. Perona; Y. Rouillard; S. Gaillard; A.N. Baranov.

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Vol 58 No 11, p 2405-2412, Sep 2002

Widely tunable GaInAsSb/AlGaAsSb quantum well (QW) lasers have been grown by molecular beam epitaxy on GaSb substrates. An experimental setup for open-path gas detection has been developed using these devices. Their emission wavelength, from 2.0 to 2.5 μm , make them suitable for the detection of many gas species in the wavelength range that corresponds to an atmospheric transmission window.

Trace Gas Measurements Using Max-DOAS in a Polluted Marine Environment
Halla, Jamie, Daniel Majonis, and Robert McLaren, York Univ., Toronto, ON, Canada.
Third International DOAS Workshop, University of Bremen, March 20-26, 2006.

Multi-axis differential optical absorption spectroscopy (MAX-DOAS) is a passive DOAS technique that uses scattered sunlight to determine the total differential slant column densities of trace gas absorbers. Measurements were taken using a MAX-DOAS instrument (developed at York University) from July 23rd through August 10th, 2005 on Saturna, Island, BC, Canada, to determine the concentration of several trace gas species from a site likely to exhibit significant interaction of urban and marine emissions. The researchers were looking for evidence of reactive halogen species, such as BrO, at mid-latitudes and exploring the use of MAX-DOAS for investigating pollutant inhomogeneities in a region. Preliminary results for trace gases (NO₂, BrO, and HCHO) are presented.

Uncertainty in Quantifying DNAPL Source Zone Distribution for In Situ Remediation Design and Performance Assessment

Gary P. Wealthall (gpwe@bgs.ac.uk) Mike. R. Lelliott, Mark. R. Cave, Colin. S. Cheney, Emily J. Whitehead (British Geological Survey, Nottingham, UK) Lawrence Houlden (Archon Environmental Consultants Limited, Cambridge, UK)
Aquifer Contamination and Insitu Remediation, 23 March 2006, British Geological Survey, Keyworth, Nottingham, UK. The Hydrogeological Group of the Geological Society.

At present, no single technique is available that adequately characterizes DNAPL source zone architecture(s) in heterogeneous geologies. Instead, a range of site characterization methods are typically applied, based on establishing sequential multiple lines of evidence. A phased investigation is described, with each successive phase building upon the information gathered and assessed in the preceding phases, where propagation of uncertainty is addressed through the use of 2-D kernel smoothing and fuzzy logic techniques to derive confidence values for the individual and combined datasets. The results reveal individual DNAPL zones defined by unique geological, hydrogeological, and contaminant characteristics. Further analysis indicates mass distribution characteristics within these zones and defines the upper and lower confidence limits, which are used to design the in situ remediation program. The authors present detailed 3-D reconstruction and visualization of the site data and examine a quantitative method to estimate uncertainty in DNAPL mass distribution.

Use of Continuous Isokinetic Samplers for the Measurement of Dioxins and Furans in Emissions to Atmosphere

Gemmill, R.

Environment Agency, UK. ISBN: 1844325504, SCHO0306BKNJ-E-P, 94 pp, Apr 2006

For many common pollutants, UK's Environment Agency requires operators to fit continuous emission monitoring systems that provide the operator with constant feedback on the levels of pollutants being emitted. There is currently no technology available to take, analyze, and display instantaneous readings of dioxins levels due to the very low levels that are emitted. These levels are so low that they are at the limits of what can be detected by the most sensitive equipment. Instead of continuous measurement, European Standard BS EN 1948 is used, which involves collecting a sample of emissions manually over 6 hours and then sending it away for

laboratory analysis. The formation of dioxins is minimized by controlling other things that can be measured continuously to prevent dioxins formation, such as combustion temperature, the amount of oxygen present, and proper operation of the abatement equipment. To keep abreast of innovations in monitoring technology, the Agency investigated the performance of two commercial systems that sample dioxins continuously. The AMESA and DMS systems are designed to sample emissions continuously over a typical period of 14 to 28 days, producing a single sample that is then analyzed. For the system testing, two operators, a municipal waste incinerator and a cement works, agreed to have these systems installed on their sites. The manufacturers of the continuous systems provided the equipment on loan free of charge. A series of lab and field tests was carried out to observe their performance as automatic sampling systems and to assess their performance against measurements made by manual sampling using BS EN 1948. The investigators found that the extremely low levels of dioxins emissions at both sites meant that the study was working at the limit of what it is possible to measure with any certainty. Both continuous systems were able to track the trends in dioxins concentrations as the processes operated; however, differences were observed between the continuous sampling systems and manual sampling and between the two continuous systems. The continuous sampling systems did not meet the requirements of BS EN 1948. The emission limit value in the WID applies to the use of BS EN 1948, and this manual sampling method remains the only acceptable way to monitor dioxins for the purpose of regulation. The majority of results were well within the 0.1ng I-TEQ/m³ emission limit value specified by regulation, irrespective of the measurement system and test site.

<http://publications.environment-agency.gov.uk/pdf/SCHO0306BKNJ-e-e.pdf>

Use of Data on Contaminant/Sediment Interactions to Streamline Sediment Assessment and Management

Apitz, S.E., B.P. Ayers, and V.J. Kirtay.

Technical Report 1918, 122 pp, Aug 2004

This report presents successful ways to use biogeochemical characterization data to optimize sediment site assessment and management. Appropriate data will help risk assessors and managers guide, define, negotiate, and comply with current regulatory and U.S. Navy guidance, as well as achieve cost reduction and more effective remedies. Sections of this guidance should help manage sediments in line with EPA guidance. As with every issue that is complex in regulatory and technical terms, all steps of the process should be designed and carried out in close collaboration and communication with all parties. This report highlights many successful aspects of contaminated sediment assessment and management. It provides site owners with examples of how to use site-specific data to compare site, background, and regional sediment signatures to address risk, determine responsibility for inputs, rank sites, and prioritize management; to help bridge the gap between remedial investigations and feasibility studies; and to provide site owners with the tools to rapidly determine what sediment management approaches are feasible for contaminated sediments at their sites—and to use site data to evaluate, communicate, and negotiate management choices. The approach of this report is to highlight some major uses for data on contaminant/sediment geochemical interactions in the assessment and management of contaminated sediments. It is not an exhaustive review of all potentialities, but it does provide many examples, case studies, and standard operating

procedures that should aid RPMs, risk assessors, and managers in using site data to evaluate, negotiate, and select management strategies.

<http://www.spawar.navy.mil/sti/publications/pubs/tr/1918/tr1918cond.pdf>

Use of Diffuse Reflections in Tunable Diode Laser Absorption Spectroscopy

Masiyano, D., D. Francis, J. Hodgkinson, and R. Tatam, Cranfield Univ., Cranfield, Bedfordshire, UK.

Photon 06, 4-7 September 2006, University of Manchester, UK.

Though tunable diode laser absorption spectroscopy (TDLAS) has great potential in trace gas detection, the sensitivity of many TDLAS practical systems is limited by the formation of unintentional Fabry-Perot interference fringes generated in the optical path between the source and detector. It might be possible to design out the problem, but such measures are complicated and can be difficult to maintain in field instruments. Recently there has been interest in using diffuse reflections within the optical path to develop remote "laser-pointer"-type gas detectors where the light is backscattered from a rough surface at ground level. Researchers are also pursuing the use of integrating spheres as multi-path gas cells and insertion of diffuse reflecting or transmitting materials in the optical path. The authors present preliminary results of the deliberate use of optical scattering in TDLAS by diffusely reflecting materials.

<http://photon06.org/OPD%20P3.8.doc>

Use of Diffusive Gradients in Thin Films (DGT) in Undisturbed Field Soils

Nowack, B., S. Koehler, and R. Schulin, Swiss Federal Inst. of Technology (ETH), Schlieren, Switzerland.

Environmental Science & Technology, Vol 38 No 4, p 1133-1138, 2004

The authors used diffusive gradients in thin films (DGT) to investigate the resupply kinetics of Cu and Zn under in situ conditions in a polluted lysimeter soil and compared the results with laboratory measurements. Results differed considerably among three types of conditions, i.e., field soil, soil cores, and homogenized soil, though the same soil material was used in all experiments. A small pool of rapidly available Zn was found in the field but not in the homogenized soil. Soil solution pH and dissolved metal concentrations also varied significantly between the soil treatments. The researchers also compared the DGT-measured effective concentration with the uptake of Cu and Zn into the shoots of *Lolium perenne* (Ryegrass) under the same three soil conditions. A close relationship was found that was not linear but could be described by a saturation-type behavior. DGT predicted plant metal uptake much better than the soil solution concentration or pH. The results of this study suggest that DGT could be used successfully under field conditions to study the kinetics of metal resupply.

<http://www.ito.ethz.ch/SoilProt/staff/nowack/publications.html>

Use of Liquid Chromatography in Tandem Mass Spectrometry to Detect Distinctive Indicators of In Situ RDX Transformation in Contaminated Groundwater

Beller, H.R. (Lawrence Livermore National Lab, Livermore, CA); K. Tiemeier (U.S. Army Support Command, Rock Island Arsenal, IL).

Environmental Science & Technology, Vol 36 No 9, p 2060-2066, 2002

Monitoring groundwater to assess the natural attenuation of contaminants involves identifying the distinctive products of pollutant degradation or transformation. In contaminated groundwater from the Iowa Army Ammunition Plant, the authors looked for three distinctive products of the explosive RDX: MNX, DNX, and TNX. These compounds are powerful indicators of RDX transformation because they have unique chemical features that reveal their origin as RDX daughter products; they have no known commercial, industrial, or natural sources; and they are well documented as anaerobic RDX metabolites in laboratory studies. The products were analyzed by LC/MS/MS (liquid chromatography/mass spectrometry/mass spectrometry) with selected reaction monitoring and internal standard quantification. Validation tests showed the novel LC/MS/MS method to be of favorable sensitivity (detection limits ~0.1 ug/L), accuracy, and precision. The products, which were detected in all groundwater samples with RDX concentrations >1 ug/L (25 out of 55 samples analyzed), were present at concentrations ranging from near the detection limit to 430 ug/L. Geographic and temporal distributions of RDX, MNX, DNX, and TNX were assessed. MNX was the typically the most abundant of the three nitroso-substituted products.

Using FTIR Spectrometry for Industrial and Environmental Gas Analysis

Webb, John D., Robert L. Spellicy, and Ralph J. Brewer.

EM [A&WMA], Nov 2003

Today's FTIR systems are less expensive, more rugged, and more capable of operating for long periods with minimal maintenance than was formerly the case in the not-too-distant past. This article discusses the application of FTIR systems for industrial and environmental gas analysis.

Using Kinetic Isotope Effects to Assess Abiotic Reductive Transformation of Organic Contaminants

Hofstetter, T. and A. Hartenbach (ETH Zentrum, Zurich, Switzerland); M. Berg (Swiss Federal Inst. of Aquatic Science and Technology (EAWAG), Dübendorf, Switzerland); R. Schwarzenbach (ETH Zentrum, Zurich, Switzerland).

The 231st ACS National Meeting, Atlanta, GA, March 26-30, 2006, ENVR 64

Reductive transformation pathways are of great relevance for the fate of many organic contaminants in anoxic soils and sediments. To increase the understanding of the factors that determine isotopic fractionation of contaminant reduction, the authors investigated the kinetic isotope effects (KIEs) of well-known abiotic reactions, such as the reduction of nitroaromatic compounds or chlorinated aliphatic hydrocarbons by various reductants. The studies report nitrogen and chlorine isotope effects for the abiotic reduction of organic compounds. Nitrogen KIEs for a series of substituted nitroaromatic compounds were almost constant at 1.030 for both homogeneous and surface-mediated reactions. In contrast, high chlorine and carbon KIEs for the homogeneous reduction of chlorinated ethanes varied over a wide range for hexa-, penta-, and tetrachloroethanes. The results suggest that both electron transfer and bond cleavage can contribute to the magnitude of isotopic fractionation. Even though these KIEs seem to be characteristic for the abiotic redox reaction, a better mechanistic understanding of the reaction pathways is needed to address the observed variability of KIEs.

Using Lidar to Measure Perfluorocarbon Tracers for the Verification and Monitoring of Cap and Cover Systems

Heiser, J.H. and A.J. Sedlacek, Brookhaven National Laboratory, Upton, NY.

BNL-75583-2006-JA, 13 pp, Dec 2005

Researchers at Brookhaven National Laboratory have used gaseous perfluorocarbon tracers (PFTs) to monitor the integrity of caps and covers for waste disposal sites. Detection of the PFTs currently uses gas chromatography techniques developed at BNL. This paper presents a potential approach to this wide-area screening problem by replacing conventional gas chromatography analysis with laser-based, lidar (light detection and ranging) detection of the PFTs. Lidar can be used to scan the surface of the cover system, looking for fugitive PFTs. If successful, an investigator could monitor by lidar for PFTs in the air just above the soil surface instead of taking samples for soil gas analysis. The advantages of using a lidar platform are multi-fold and include the elimination of soil monitoring ports. Bench-top and pilot-scale indoor experiments using a continuous-wave, line-tunable, infrared CO₂ laser were used to detect PMCH (perfluoromethylcyclohexane, one of a group of PFTs used at BNL). Laboratory measurements of the absorption cross-section were the same order of magnitude compared to literature values for similar perfluorocarbon compounds. Initial bench-top, fixed-cell-length experiments were successful in detecting PMCH to levels of 10 ppb-m. To improve the lower limit of detection, a HgCdTe detector was acquired that was more specific to the lasing region of interest and had a higher sensitivity at this spectral region. Using a pilot-scale lidar system in a 40m indoor hallway, air concentrations of PMCH were then measured down to 1 ppb-m. These results are very promising and show great potential for monitoring the integrity of cover systems using lidar and PFTs. [This paper has been submitted to Water, Air, and Soil Pollution.] <http://www.ecd.bnl.gov/pubs/BNL-75583-2006-JA.pdf>

Versatile Mobile Lidar System for Environmental Monitoring

Weibring, P., H. Edner, and S. Svanberg.

Applied Optics, Vol 42 No , p 3583-3594, 2003

The optical and electronic systems of a mobile lidar (light detection and ranging) system for environmental monitoring are housed in a truck with a retractable rooftop transmission and receiving mirror, connected to a 40-cm-diameter vertically angled telescope. Two injection-seeded Nd:YAG lasers are employed in connection with an optical parametric oscillator-optical parametric amplification transmitter, allowing deep-UV to mid-IR wavelengths to be generated. Multi-wavelength differential absorption lidar for simultaneous measurements of several spectrally overlapping atmospheric species is supported by fast switching that employs piezoelectric drivers. The system can also be used in an imaging multispectral laser-induced fluorescence mode on solid targets. The potential of the monitoring system is illustrated by application to industrial atmospheric mercury and hydrocarbon emissions, volcanic sulfur dioxide plume mapping, fluorescence lidar probing of seawater, and multispectral fluorescence imaging of the facades of a historical monument.

Water Table Monitoring Project Design

Noble, C.V., U.S. Army Engineer Research and Development Center, Vicksburg, MS.
ERDC TN-WRAP-06-2, 13 pp, Jan 2006

This document provides guidance for planning and implementing a wetland hydrology monitoring project for wetland regulatory purposes. It is intended to address situations commonly encountered in areas where the "Technical Standard for Water-Table Monitoring of Potential Wetland Sites" (U.S. Army Corps of Engineers, 2004) might be applied. It is not intended to be all-inclusive, or to supersede wetland determinations based on indicators of hydric soils, hydrophytic vegetation, and wetland hydrology. Hydrology studies designed to combine additional information about hydric soils or water quality are beyond the scope of this document. <http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=ADA444616&Location=U2&doc=GetTRDoc.pdf>

Well Test Flare Plume Monitoring, Phase II: DIAL Testing in Alberta

Chambers, Allan, Alberta Research Council, Inc.

Canadian Association of Petroleum Producers, Project No: CEM 7454-2003, 89 pp, Dec 2003

Differential absorption light detection and ranging (DIAL) technology was field-tested in Alberta as a means to monitor ambient SO₂ concentrations in the vicinity of sour gas well test flares and to track the SO₂ plume position, measure the combustion efficiency of well test and solution gas flares, and measure fugitive emissions of methane and other hydrocarbons from gas processing facilities. DIAL is a laser-based optical method that can measure the concentration of gases in the atmosphere up to 2 km distant with detection limits in the order of parts per billion. By combining DIAL-measured 2D concentration maps with measured wind speed, the mass emissions of the species in a plume can be calculated. Spectrasyne Ltd., UK, was subcontracted to bring their DIAL equipment and operating staff to Alberta during May-June of 2003. Over a 4-week period, DIAL surveys were performed at one sweet and three sour gas processing plants. Based on the tail gas incinerator plume calibration, DIAL measurements of SO₂ mass flux in a plume were within 10% of the plant data measured in the stack. During the sour gas well test flaring in the foothills, the application of DIAL to remotely measure SO₂ up to 2 km at concentrations suitable for ambient air monitoring requirements was demonstrated, as well as its utility in tracking the SO₂ plume from the flare. At the four gas plants surveyed with DIAL, fugitive emissions of methane ranged from 104 to 450 kg/hr and fugitive emissions of C₂+ ranged from 38 to 342 kg/hr. Using the concentration profiles measured with the DIAL method, the fugitive emissions were allocated to various areas of the plant. The DIAL method also located significant leaks at two of the gas plants and quantified the amount of these leaks. The combustion efficiency of the well test flare and two solution gas flares were measured, with hydrocarbon combustion efficiencies ranging from 72 to 98 %. Based on the DIAL measurement of SO₂ flux in the well test flare plume, the conversion of H₂S to SO₂ in the flare ranged from 46 to 72% with indications that H₂S was converted to other sulfur compounds in the flare.

<http://www.ptac.org/env/dl/envp0402fr.pdf>

Well Test Flare Plume Monitoring, Phase II: DIAL Testing in Alberta

Chambers, Allan, Alberta Research Council, Inc.

Canadian Association of Petroleum Producers, Project No: CEM 7454-2003, 89 pp, Dec 2003

Differential absorption light detection and ranging (DIAL) technology was field-tested in Alberta as a means to monitor ambient SO₂ concentrations in the vicinity of sour gas well test flares and to track the SO₂ plume position, measure the combustion efficiency of well test and

solution gas flares, and measure fugitive emissions of methane and other hydrocarbons from gas processing facilities. DIAL is a laser-based optical method that can measure the concentration of gases in the atmosphere up to 2 km distant with detection limits in the order of parts per billion. By combining DIAL-measured 2D concentration maps with measured wind speed, the mass emissions of the species in a plume can be calculated. Spectrasyn Ltd., UK, was subcontracted to bring their DIAL equipment and operating staff to Alberta during May-June of 2003. Over a 4-week period, DIAL surveys were performed at one sweet and three sour gas processing plants. Based on the tail gas incinerator plume calibration, DIAL measurements of SO₂ mass flux in a plume were within 10% of the plant data measured in the stack. During the sour gas well test flaring in the foothills, the application of DIAL to remotely measure SO₂ up to 2 km at concentrations suitable for ambient air monitoring requirements was demonstrated, as well as its utility in tracking the SO₂ plume from the flare. At the four gas plants surveyed with DIAL, fugitive emissions of methane ranged from 104 to 450 kg/hr and fugitive emissions of C₂+ ranged from 38 to 342 kg/hr. Using the concentration profiles measured with the DIAL method, the fugitive emissions were allocated to various areas of the plant. The DIAL method also located significant leaks at two of the gas plants and quantified the amount of these leaks. The combustion efficiency of the well test flare and two solution gas flares were measured, with hydrocarbon combustion efficiencies ranging from 72 to 98 %. Based on the DIAL measurement of SO₂ flux in the well test flare plume, the conversion of H₂S to SO₂ in the flare ranged from 46 to 72% with indications that H₂S was converted to other sulfur compounds in the flare.
<http://www.ptac.org/env/dl/envp0402fr.pdf>

Whole Cell Biosensor for PCB Analysis Based on Optical Detection

Gavlasova, P. and G. Kuncova (Czech Academy of Sciences, Prague, Czech Republic); L. Kochankova and M. Mackova (ICT, Prague).
Photon 06, 4-7 September 2006, University of Manchester, UK.

A whole-cell optical sensor of polychlorinated biphenyls (PCBs) is based on the production of colored intermediates by silica-entrapped cells. The reusable whole-cell biosensor (WCB) was prepared by co-immobilization of cells *Pseudomonas* species 2 with biphenyl in the silica matrix. The sensors were exposed to 13 individual PCB congeners, the commercial PCB mixture Delor 103, PAHs (anthracene, pyrene, phenanthrene), solvents (toluene, xylene), naphthalene, 1-methylnaphthalene, and dibenzofuran. The silica-entrapped cells produce yellow intermediates selectively in the presence of two PCB congeners: 2,4,4-trichlorobiphenyl and 2,4,5-trichlorobiphenyl, and of Delor 103. The PCBs detection was not influenced by PAHs. Naphthalenes and solvents decreased production of yellow intermediates.
<http://photon06.org/OPD%20P3.9.doc>

Whole-Cell Living Biosensors--Are They Ready for Environmental Application?

Harms, H. (UFZ Centre for Environmental Research Leipzig-Halle GmbH, Leipzig, Germany); M.C. Wells (Tennessee Tech, Cookeville); J.R. van der Meer (Univ. of Lausanne, Switzerland).
Applied Microbiology and Biotechnology Volume 70, Number 3, p 273 - 280, Apr 2006

The research into cellular biosensors is still mostly in a proof-of-principle or demonstration phase and is not close to extensive or commercial use outside of academia. The reviewers consider the motivations for bioreporter developments and discuss the suitability of

extant bioreporters for the proposed applications to stimulate complementary research and to help researchers develop realistic objectives. The paper includes the identification of some popular misconceptions about the qualities and shortcomings of bioreporters.

<http://instructional1.calstatela.edu/ckhachi/REU/Projects/Arsenic/Biosensor/van%20der%20Meer%202002.pdf>

Wide Range Digitizer for Chem-Bio LIDAR

Green, Norman and Raphael Moon.

Proceedings of the 24th Army Science Conference, 29 Nov-2 Dec 2004, Orlando, Florida. NTIS: ADA433626, 3 pp, Dec 2004

The frequency agile laser sensor is an active standoff chemical detector developed at the Edgewood Chemical Biological Center for the purpose of remotely sensing chemical warfare agents. Despite the success of the Laser Standoff Chemical and Biological Detection (LSCBD) program, one major limitation of the LSCBD system has been data acquisition and processing capability. In a LIDAR system, the received analog signal is detected, amplified, and digitized for subsequent computer processing. Receiver amplifier gain is usually adjusted periodically so that signal amplitude applied to the digitizer is not too large, which can result in a signal clipping, nor too small, which can result in poor digitizer resolution. In LIDAR applications, the received signal amplitude changes rapidly, and proper gain adjustment in real time is difficult. The Laser Standoff Detection Group has addressed this problem by the design of a unique, high-resolution, wide-range digitizer. Four A/D converters, each with a progressively higher voltage range, are configured in a circuit in which the input signal is applied simultaneously to all A/D converters. Digital output signals are selected from the A/D converter having the lowest voltage range not exceeded by the input signal. These data comprise 16-bit data words, which are sent to a digital signal processor (DSP). The DSP processes the LIDAR signal and sends data via a high-speed serial link to the LIDAR computer. This design eliminates the need for manual or automatic gain control amplifiers in the LIDAR data acquisition system. Digital signal resolution is maintained for small signals, yet large amplitude signals are not distorted due to signal clipping.

<http://handle.dtic.mil/100.2/ADA433626>

SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) AWARDS

U.S. Department of Energy

Algorithms for Multilook Effluent Detection and Identification (DOE 2006 SBIR Phase 2)

Pierre V. Villeneuve, Principal Investigator, villeneuve@spacecomputer.com

Space Computer Corporation, Los Angeles, CA; 310-481-6000

DOE Grant No. DE-FG02-05ER84168

Period of performance: NA

Amount: \$749,955

Hyperspectral imaging systems are used for the remote detection and identification of gaseous chemical effluents, which is needed for monitoring suspected nuclear, biological, or

chemical weapons manufacturing sites. This project will develop automated software that uses a time series of remote target observations from infrared hyperspectral imaging sensors to dramatically improve the detection and identification of chemicals in effluent plumes. In Phase I, optimal clutter suppression, based on co-registered multi-look images, yielded gains in plume detection sensitivity on the order of 100% for many industrial chemicals. Multi-look methods of chemical identification realized an initial 10% improvement in false alarm reduction, and the potential for much greater improvement was indicated. Phase II will (1) refine and optimize the multi-look algorithms, (2) implement the software prototype, and (3) demonstrate prototype performance using airborne and ground-based sensor data from target sites with simulated proliferant activities. The software package for detecting and quantifying effluent chemicals from multi-temporal hyperspectral imagery should be of interest to intelligence image analysts performing time-critical tasks such as WMD threat location or bomb damage assessment, military units concerned with tactical chemical threat warning, or civilian agencies requiring warning of the presence of dangerous chemicals.

Broadly Tunable Quantum Cascade Laser Technology for Remote Sensing (DOE 2006 STTR Phase 1)

John Barry McManus, mcmanus@aerodyne.com

Aerodyne Research, Inc., Billerica, MA; 978-663-9500. Partnered with Rice University, Houston, TX

DOE Grant No. DE-FG02-06ER86264

Period of performance: NA

Amount: \$99,994

National security interests related to the nonproliferation of weapons of mass destruction require the remote detection of trace gases associated with the nuclear fuel cycle. Newly developed, mid-infrared, quantum cascade lasers have the potential to contribute to this application. These small solid state lasers produce relatively high power in the infrared band of light where many gases can be most sensitively detected, and without the usual need for extreme cooling; however, the tuning range of these lasers needs improvement to allow more gases to be detected. To develop a widely tunable quantum cascade laser, this project will design an external cavity laser light source based on a quantum cascade gain medium. A "coupled-cavity tuning" technique will be employed to compensate for the usual technical limitations of such laser designs, thereby achieving wide and uniform emission tuning. During Phase I, the small business will perform remote sensing experiments with currently-available quantum cascade lasers to guide the development of instrument optics, software, and robust integrated designs. The research institution will further develop the coupled-cavity tuning technique to produce a widely-tuning laser module, which will be added to a remote sensing module during Phase II. Commercial applications of the proposed technology include remote pipeline leak detection, remote trace gas detection for agriculture, industrial emissions monitoring, and environmental science. Security-related government applications include the remote inspection of shipping containers, monitoring industrial facilities for evidence of prohibited chemicals, or sensing battlefield chemical weapons.

Characterization of Carbonaceous Particles: Aerosol Mass Spectrometry and Light Scattering
(DOE 2006 SBIR Phase 2)

Timothy B. Onasch, Principal Investigator, onasch@aerodyne.com

Aerodyne Research, Inc., Billerica, MA; 978-663-9500

DOE Grant No. DE-FG02-05ER84268

Period of performance: NA

Amount: \$748,839

Aerosol particles have important effects on visibility, acid deposition, climate, and human health. A large fraction of the anthropogenic aerosol is generated from energy-related activities, and organic compounds are known to constitute a significant fraction of ambient aerosol mass in many locations. Real-time, size-resolved, quantitative instruments for the identification, speciation, and source apportionment of carbonaceous aerosols are lacking. An innovative thermal desorption, time-of-flight aerosol mass spectrometer recently has been developed with capabilities that can fill a critical need for size-resolved, quantitative chemical composition data on aerosol particles. This project will develop and demonstrate a light-scattering module for this instrument, which will enable full characterization of carbonaceous components, including their state of mixing (and atmospheric aging), along with other chemical components such as inorganics and dust. In Phase I, the light scattering system was optimized and installed in a quadrupole aerosol mass spectrometer, ray tracing calculations were performed to optimize optical detection, software for analyzing data on individual particles in real-time was developed, and the system capabilities were quantified. Phase II will continue the development of the light scattering module and its incorporation into the new time-of-flight aerosol mass spectrometer. The combined instrument will be tested on multiple aerosol systems in the laboratory and during a future field study. Beyond the application for atmospheric research, the combined aerosol mass spectrometer and light scattering module could provide aerosol measurement capabilities for a variety of monitoring applications. A portable instrument could be employed in industrial process monitoring and chemical and biological warfare agent identification.

Development of HydroImage: A User-Friendly Hydrogeophysical Characterization Software
Package (DOE 2006 STTR Phase 2)

Chin Man W. Mok, Principal Investigator, cmok@geomatrix.com

Geomatrix Consultants, Inc., Oakland, CA; 510-663-4100. Partnered with Lawrence Berkeley
National Laboratory, Berkeley, CA

DOE Grant No. DE-FG02-05ER86244

Period of performance: NA

Amount: \$750,000

At thousands of sites across the U.S., groundwater and soils are contaminated with hazardous chemicals, metals, and radioactive contaminants. There is strong interest in reducing the costs of cleanup and long-term monitoring. This project will develop a user-friendly software package that integrates continuous geophysical data with limited borehole data to estimate hydrogeological parameters of interest in the subsurface. The software package can be used to significantly enhance site-conceptual models and improve the design and operation of remediation systems. Phase I developed the basic components for the software package: a graphical user interface, a radar and seismic tomography inversion tool, a geostatistical integration tool, a petrophysical model development tool, and a Bayesian integration tool. Phase

It will augment, refine, and test the software package using hydrological and geophysical data collected at several sites. The refinements will include (1) an expansion of all components described above, (2) an ability to input and utilize surface geophysical, cone penetrometer testing, and processed electrical resistivity data, (3) the development of workflow modules to guide users through the estimation procedure, (4) the development of a centralized database and enhanced visualization capabilities, and (5) the development of quality control and help modules. It is anticipated that the software package would be licensed to companies interested in providing groundwater monitoring services to the environmental industry, site owners, and consultants.

External Cavity Stabilized LWIR QCL (DOE 2006 SBIR Phase 2)

Joel M. Hensley, Principal Investigator, hensley@psicorp.com

Physical Sciences Inc., Andover, MA; 978-689-0003

DOE Grant No. DE-FG02-05ER84158

Period of performance: NA

Amount: \$749,911

Lasers based on quantum cascade (QC) gain media represent a powerful new tool for optical detection in the infrared spectral region, that are needed to help detect the proliferation of weapons of mass destruction. They have been demonstrated to be reliable, compact, efficient, bright sources of spectrally narrow radiation in midwave-, longwave-, and far-infrared. The ultimate utility of QC lasers, however, will be greatly enhanced if their tuning range can be increased. In this project, the quantum cascade gain medium will be incorporated into an external optical cavity to increase the tuning range by over an order of magnitude. In addition to designing the external optical cavity, the quantum cascade medium will be modified to suppress the intrinsic optical cavity formed by its front and back facets. Phase I demonstrated that continuous-mode/hop-free tuning, with both cryogenic and room temperature quantum cascade lasers operating near 8 microns, could be achieved when the lasers were built into an external optical cavity. To reduce the facet reflectance, approaches including horizontal angling, vertical angling, and anti-reflection (AR) coating were evaluated. The room temperature, anti-reflection coated laser performed best. In Phase II, a commercial, prototype, external-cavity quantum cascade laser system, emitting in the 8 to 14 micron spectral region, will be developed. This external cavity system will have a tuning range over 350 nm, which would be more than an order of magnitude greater than its inherent tuning range. The broadly-tunable, longwave-infrared, external-cavity quantum cascade laser should meet an unfilled need for narrow linewidth spectroscopic systems in the 8 to 14 micron spectral region. The systems should find use in the high-precision spectroscopy of gas molecules related to national defense, homeland security, treaty verification, and industrial safety. Customers would include researchers developing advanced sensors for hazardous gas leak detection and process monitoring.

A Fiber Optic Multipass Raman Probe and Instrumentation for Monitoring Flammable Gases in High Level Waste Tanks (DOE 2006 SBIR Phase 2)

Job M. Bello, Principal Investigator, bello@eiclabs.com

EIC Laboratories, Inc., Norwood, MA; 781-769-9450

DOE Grant No. DE-FG02-05ER84278

Period of performance: NA

Amount: \$749,931

DOE has 280 underground tanks used to process and store over 90 million gallons of high-level radioactive chemical waste. The conditions in the tanks are conducive to the formation of flammable gases such as hydrogen, ammonia, and methane, as well as fire accelerants (oxidizers) such as nitrous oxide. An accumulation of these flammable gases above their lower flammability limit (LFL) increases the risk of fire and explosion. To mitigate these risks, this project will develop a Raman instrument that can be deployed inside the tanks for monitoring the concentration of these hazardous gases below their lower flammability limit. Phase I showed that flammable gases such as hydrogen and methane can be detected at concentrations below their lower flammability limit in near real time with a multipass retroreflector Raman cell. In its current configuration, the limit of detection of the multipass Raman probe is at 10% of the gases' lower flammability limit. Phase II will involve refinements to the multipass Raman gas probe design and the associated Raman instrumentation to permit gas detection at concentrations lower than 10% of the lower flammability limit. A deployable probe and instrument will be developed for field-testing in a high level waste tank at the Savannah River National Laboratory (SRNL). A sensitive Raman probe also could benefit the private sector in relation to (1) pollutant monitoring, where the probe could be used to monitor the release of hazardous gases from industrial sites for regulatory purposes, and (2) process control, such as in furnace atmosphere control monitoring, where the control and monitoring of nitrogen, carbon monoxide, hydrogen, ammonia, carbon dioxide, oxygen, and other hydrocarbon gases is required.

Fiber-Optic Sensor with Simultaneous Temperature, Pressure, and Chemical Sensing Capabilities (DOE 2006 STTR Phase 2)

Jermaine L. Kennedy, Principal Investigator, micromaterials@yahoo.com

MicroMaterials, Inc., Tampa, FL; 813-627-0474. Partnered with University of South Florida, Tampa, FL

DOE Grant No. DE-FG02-05ER86262

Period of performance: NA

Amount: \$750,000

This project will develop a fiber-optic sensor that combines temperature, pressure, and chemical sensing capabilities into a single strand of sapphire fiber, using a novel measurement strategy. The integration of the three measurement capabilities into a single probe minimizes both the cost and intrusiveness of the device. Phase I demonstrated the feasibility of the concept for measuring temperature, pressure, and chemical composition. Crucial data were obtained that allowed the capabilities of each sensor to be projected. Additionally, quantitative models for the three sensors were developed. In Phase II, the temperature, pressure, and chemical sensors will be optimized individually, then an integrated probe incorporating all three sensors will be fabricated and tested. Finally, a 90-day life test of the integrated system, under conditions typically found in chemical reactors, will be conducted. The multifunctional fiber-optic sensor

should be suitable for the on-line monitoring of process streams in the chemical and petrochemical industries. Parts of the sensor package also should have commercial value in the aerospace industry, in the processing of electronic materials, and in environmental monitoring.

Field-Deployable Gas Analyzer for MMV Applications (DOE 2006 SBIR Phase 1)

Anthony O'Keefe, Principal Investigator, a.okeefe@lgrinc.com

Los Gatos Research, Mountain View, CA; 650-965-7772

DOE Grant No. DE-FG02-06ER84606

Period of performance: NA

Amount: \$99,974

One of the key components of the DOE Carbon Sequestration Program involves the monitoring and verification of injected carbon dioxide, including the detection of leaks. An ideal analyzer would provide highly accurate carbon dioxide measurements, cover a broad area, and be capable of distinguishing between carbon dioxide leakage and ambient biological fluctuations. This project will utilize a proprietary technology to fabricate a gas analyzer that is capable of quantifying trace quantities of carbon dioxide, distinguishing between anthropogenic and biogenic gases, and monitoring methane leakage for mitigation of fugitive emissions. Phase I will demonstrate technical feasibility by fabricating a gas analyzer optimized for sequestration studies. The prototype will be tested in the laboratory using calibrated standards to demonstrate a rapid accurate response over the dynamic range of interest. Further testing will establish the instrument's long-term precision over a wide range of temperature, humidity, and mechanical stress, similar to those found at an actual field site. A gas sampling system will be designed with an external probe that is capable of sampling carbon dioxide from both ambient air and soil. Finally, the unit will be deployed at an ongoing DOE carbon sequestration field project (Frio, Texas) and at the Red Butte Canyon Research Natural Area (Salt Lake City, Utah). A field-deployable gas analyzer for carbon dioxide isotopes and methane should have a significant impact on the refinement of carbon sequestration schemes. Several other potentially lucrative markets would benefit from this analytical device: environmental research laboratories and airborne pipeline leak monitoring.

Field Portable Gel Element Arrays for Microbial Community Profiling in Subsurface Sediments and Groundwater (DOE 2006 SBIR Phase 1)

Darrell P. Chandler, Principal Investigator, dchandler@akonni.com

Akonni Biosystems, Inc., New Market, MD; 301-524-7867

DOE Grant No. DE-FG02-06ER84412

Period of performance: NA

Amount: \$99,908

To implement effective, safe, and scientifically-based approaches to the remediation of contaminated sites, engineers and policy makers require fundamental information on microorganisms in the subsurface. In particular, information is needed to identify factors that affect specific changes in contaminant speciation and mobility, how microbial populations respond to natural or engineered changes, and how shifts in population structure are related to or constitute signatures of bioremediation effectiveness. This project will develop technology for a field-deployable, facile, near-real-time analysis system that will provide the information needed

to monitor microbial activity and composition in the subsurface. Phase I will (1) automate a metal-, sulfate-, and nitrate-reducer gel element array sub-circuit for direct rRNA hybridization and detection, with the option of performing on-card thermal dissociation analysis; (2) demonstrate the on-card identification of *Geobacter chapellei* rRNA and natural microbiota from nucleic acids processed (off-card) from subsurface sediment; and (3) develop and test a prototype sample preparation sub-circuit for rRNA purification. The technology should enable the near real-time, direct identification of in situ contaminant transformation, thereby improving the management of on-site cleanup efforts. The basic technology platform could be expanded to monitor other microorganisms capable of transforming chlorinated solvents, aromatic hydrocarbons, and other contaminants of concern.

Field-Worthy UV Backscatter Lidar for Cirrus Studies (DOE 2006 SBIR Phase 1)

David M. Sonnenfroh, Principal Investigator, sonnenfroh@psicorp.com

Physical Sciences Inc., Andover, MA; 978-689-0003

DOE Grant No. DE-FG02-06ER84427

Period of performance: NA

Amount: \$99,870

Cirrus clouds are an important element in atmospheric radiative transfer and impact both climate and climate change. In recent years, the spatial coverage and frequency of cirrus clouds has been increasing, and new instrumentation is needed to measure the occurrence and spatial extent of these clouds to develop a database for climate modelers. To address this need, this project will develop and demonstrate a compact UV lidar that will utilize an all-solid-state UV laser for the transmitter. The UV lidar will provide a new capability to monitor subvisual cirrus clouds as compared to the existing MicroPulse Lidar. Phase I will demonstrate key components for an air-cooled UV laser that will serve as the heart of the new lidar. The required power and pulse repetition frequency will be demonstrated. A complete conceptual design for a field-prototype, UV backscatter lidar will be developed and used to fabricate and test the prototype in Phase II. The new compact lidar system should fulfill an important near-term need for a highly autonomous sensor for widespread use by monitoring networks. The basic technology also should be applicable to the monitoring of tropospheric ozone and sulfur dioxide.

High-Performance Atmospheric Carbon Dioxide Analyzer (DOE 2006 SBIR Phase 1)

Jeffrey S. Pilgrim, Principal Investigator, jpilgrim@vistaphotonics.com

Vista Photonics, Inc., Santa Fe, NM; 505-466-3953

DOE Grant No. DE-FG02-06ER84490

Period of performance: NA

Amount: \$100,000

High sensitivity, precision, and selectivity, in the presence of atmospheric contaminants, are a challenge to optical detection methods for the detection of carbon dioxide. In this project, an emerging, ultra-trace photoacoustic spectrometer, initially developed for use with simple laser diodes, will be coupled with an infrared laser-enhancement cavity to provide exceptional sensitivity and selectivity to the measurement of atmospheric carbon dioxide. The laser enhancement technique will employ a broadly tunable, high-power solid-state laser operating at infrared wavelengths, allowing detection of multiple species. In Phase I, a bench-top, diode-

pumped solid state laser, operating with broad wavelength tuning in the infrared region, will be designed and built. The laser will serve as the platform for a cavity-enhanced photoacoustic spectrometer. The high power and broad wavelength tuning of the solid state laser, combined with photoacoustic detection, will enable parts-per-billion detection of carbon dioxide. The technology should be applicable to the detection of many trace species in addition to carbon dioxide, for much less cost than commercial systems that only target one species. Specific areas of application include process gas analysis, occupational safety, and homeland security.

Imaging the Stratigraphy Around a CPT Penetration Using a Combined ERT and CPT Method (DOE 2006 STTR Phase 1)

Wesley L. Bratton, Principal Investigator, bratton@vistaengr.com

Vista Engineering Technologies, LLC, Kennewick, WA; 509-737-1377. Partnered with Lawrence Livermore National Laboratory, Livermore, CA

DOE Grant No. DE-FG02-06ER86292

Period of performance: NA

Amount: \$99,888

To determine the fate and transport of contaminants generated from past weapons production activities, there is a need to measure the key factors that affect the flow and transport of water and contaminants in the shallow subsurface. Specifically, a method is needed for the real-time imaging of the stratigraphy in the shallow subsurface within 40 meters or more of a CPT (cone penetrometer technology) push or a monitoring well as the penetration is conducted. This project will develop a method to accomplish this imaging, using electrical resistance measurements between an array of electrodes along the ground surface and a electrode mounted on the CPT probe. Phase I will use numerical modeling and scaled laboratory tests to evaluate the feasibility of using electrical resistance tomography (ERT), implemented with CPT, to image the subsurface stratigraphy within several meters of the CPT location. Current subsurface characterization techniques typically provide only point measurements and are not able to reach out past the borehole location to determine whether layers are continuous or pinch out away from the borehole. The combined ERT-CPT approach should permit real-time mapping of the subsurface stratigraphy several meters away from the borehole, providing a much improved image of the subsurface.

Innovative Aerosol Collector for On-Line Analysis of Individual Particulate Organics (DOE 2006 SBIR Phase 2)

John T. Jayne, Principal Investigator, jayne@aerodyne.com

Aerodyne Research, Inc., Billerica, MA; 978-663-9500,

DOE Grant No. DE-FG02-05ER84269

Period of performance: NA

Amount: \$749,074

Standard analytical methods for detailed aerosol chemical speciation require long sampling times, are subject to artifacts during aerosol collection and storage, and are labor intensive. This project will develop an Aerosol Collector Module and demonstrate its feasibility for routine measurements of ambient and laboratory-generated aerosols in near real time with high time resolution (< 1 hour averages), and without artifacts due to filter sampling and storage.

Phase I designed and assembled the aerosol collection chamber, connected it to an existing vacuum chamber, and prepared an interface to analytical instruments. Control hardware and software were designed and implemented. Laboratory-generated organic particles were used to evaluate the concept. During Phase II, an integrated, stand-alone Aerosol Collector Module will be developed. Further improvements to the hardware will improve sensitivity and linearity. A scheme to obtain particle size measurements will be implemented. Finally, the performance of the Aerosol Collector Module will be demonstrated in field measurements of ambient aerosol particles. The Aerosol Collector Module should provide a universal interface for aerosol collection and concentration and should easily be adapted to existing analytical techniques and new spectrometric techniques. The instrument should be ideal for the on-line characterization of airborne particles emitted from anthropogenic and natural or photochemically-produced sources in the atmosphere.

In-Situ Analytical System for Remote Determination of ^{90}Sr Flux through the Aquifer (DOE 2006 STTR Phase 1)

Scott R. Burge, Principal Investigator, burgenv@globalcrossing.net

Burge Environmental, Inc., Tempe, AZ; 480-968-5141. Partnered with Battelle Memorial Institute, Richland, WA

DOE Grant No. DE-FG02-06ER86266

Period of performance: NA

Amount: \$99,697

The long-term monitoring of groundwater contamination plumes, needed to determine the fate of contaminants generated from past weapons-production activities, is expensive and labor-intensive. Because of the high costs, monitoring programs may collect less data than is needed to fully understand the fate and transport mechanisms of the contaminants. One source of the high costs is the expense associated with off-site, analytical laboratory services, which may take months before analytical results are returned. If analyses could be performed using remote analytical systems, tremendous cost benefits and increases in data quantity would be possible. This project will design, fabricate, and deploy a remote in situ monitoring system capable of measuring specifically targeted radionuclides in groundwater. Phase I will design a ^{90}Sr analytical system, which will be capable of preconcentrating ^{90}Sr from groundwater and then measuring the ^{90}Y daughter product via the Cherenkov detection technique. A monitoring system capable of simultaneous measurement of groundwater conductivity and pH, in addition to the ^{90}Sr analyzer module, will be fabricated for bench testing. The automated monitoring system, which will be designed for a "plug and play" configuration, will employ modular configuration and remote detection capabilities, enabling the system to be used in environmental restoration, homeland security, and national defense applications.

In Situ Optical Monitor for Waste Tank Gases (DOE 2006 SBIR Phase 2)

Jeffrey S. Pilgrim, Principal Investigator, jpilgrim@vistaphotonics.com

Vista Photonics, Inc., Santa Fe, NM; 505-466-3953

DOE Grant No. DE-FG02-05ER84307

Period of performance: NA

Amount: \$750,000

DOE waste storage tanks require continuous monitoring of species in solid, liquid, and gaseous phases. Gas-phase species of interest include ammonia, methane, carbon dioxide, and hydrogen. This project will develop in situ optical sensors that selectively and sensitively detect ammonia, methane, carbon dioxide, hydrogen, and oxygen in the waste tank headspace. The sensors will take advantage of a rugged, compact, optical absorption method and inexpensive near-infrared lasers. In Phase I, an optical spectrometer for the detection of ammonia, methane, carbon dioxide, hydrogen, and oxygen was constructed, based on a single common sample cell. The sensitivity of the spectrometer for each species was quantified. In Phase II, fully-integrated sensor prototypes, based on laser-diode photoacoustic spectroscopy, will be constructed for waste tank headspace analysis, and standard operating protocols for the sensors will be established. The prototypes will be refined through beta-testing in several field applications, which are also Phase III commercialization opportunities. The new spectrometer, which would offer high-performance in a rugged compact package, could be manufactured inexpensively relative to existing devices of comparable performance. The instrument would offer price, performance, and physical advantages in a variety of gas detection applications, such as atmospheric monitoring, environmental regulatory compliance, process gas analysis, and biomedical breath diagnostics.

A Laser-based Instrument Platform for Measuring Methane and Other Trace Gases (DOE 2006 SBIR Phase 2)

Liukang Xu, Principal Investigator, liukang.xu@licor.com

LI-COR Biosciences, Lincoln, NE; 402-467-3576

DOE Grant No. DE-FG02-05ER84283

Period of performance: NA

Amount: \$750,000

Robust and reliable trace-gas analyzers (e.g., for isotopic carbon, methane, nitroxide, ammonia, etc.), suitable for long-term measurements, are not commercially available. This project will develop a tunable diode, laser-based, open-path methane analyzer using newly-developed laser technology. The new analyzer will be suitable for deployment over a wide range of ecosystems to understand methane exchange between the atmosphere and the surface. In Phase I, an open-path methane analyzer, with a newly available vertical cavity surface emitting laser (VCSEL) and wavelength modulation spectroscopy (WMS), was developed. The resolution of the analyzer was shown to be better than 10 ppb at a 10-Hz sampling rate, exceeding the required specifications for methane flux measurement; therefore, even low methane fluxes can be measured using eddy covariance with this instrument. Phase II will further develop the open-path methane analyzer by adding a multiple-pass Herriott optical cell to the VCSEL and WMS. Instrument-embedded software and application software also will be developed. The analyzer will be capable of field deployment for methane flux measurement over various ecosystems and other surface contexts (e.g. landfills and animal husbandry lots). The lack of robust and reliable methane analyzers has limited observations of methane exchange between terrestrial ecosystems and the atmosphere to short-time intervals only. The new analyzer should allow measurements of methane exchange to be made year-round, with a minor maintenance requirement. The hardware and signal-processing software developed for the analyzer should provide the basis for developing other trace gas and isotopic element analyzers, including but not limited to analyzers for ammonia, nitroxide, carbon isotope, and oxygen isotope.

Laser-based Sensor for Routine, High Precision, Field Measurements of Ambient CO₂ (DOE 2006 SBIR Phase 2)

David M. Sonnenfroh, Principal Investigator, sonnenfroh@psicorp.com

Physical Sciences Inc., Andover, MA; 978-689-0003

DOE Grant No. DE-FG02-05ER84296

Period of performance: NA

Amount: \$749,902

Trace species such as carbon dioxide, carbon monoxide, and methane are important in the carbon cycle of the atmosphere and in global climate change. New, compact, low-maintenance, and low-cost instrumentation is required to make measurements of these trace gases with high specificity and sensitivity in national and international monitoring networks. This project will design and demonstrate a new sensor for high precision measurement of ambient CO₂. The sensor will combine advances in diode laser technology with cavity enhanced absorption methods, resulting in a measurement precision on the order of 1 in 3,000. The cost will be low enough to allow wide deployment in atmospheric monitoring networks. During Phase I, a prototype laboratory sensor was created by coupling a tunable diode laser to a high finesse optical cavity, and the required measurement precision for ambient monitoring of CO₂ was demonstrated. A complete conceptual design for a compact lightweight sensor, which is particularly well suited for network monitoring, was developed. A production cost model indicated that the sensor design can meet the target acquisition price of \$5,000 per copy when produced in volume. In Phase II, an alpha prototype sensor will be fabricated. Extensive characterization of sensor performance, as well as in-house environmental testing, will be carried out. The sensor will be demonstrated in the field at several venues. By the end of the Phase II, a complete design for a beta-prototype will be developed. Applications include environmental and air quality monitoring, combustion emissions analysis, fugitive emissions control, industrial process control, and contraband detection.

MEMS Correlation Spectrometer for High Precision CO₂ Measurements (DOE 2006 SBIR Phase 1)

David S. Bomse, Principal Investigator, dbomse@swsciences.com

Southwest Sciences, Inc., Santa Fe, NM; 505-984-1322

DOE Grant No. DE-FG02-06ER84436

Period of performance: NA

Amount: \$100,000

A new type of high-precision optical sensor combining traditional grating spectroscopy with a micro-electro-mechanical system mirror array will provide significant improvement in detection sensitivity and precision for carbon dioxide. This sensor will be compact and rugged, and will be able to operate unattended for extended periods of time. In Phase I, the methodology will be demonstrated and parameters for the mirror array will be optimized. Two different spectral bands will be compared to ascertain the best region for operation, with respect to precision, cost, and reliability. The low-cost, field-deployable instrument should find use by government agencies for the rapid and precise measurements of important gases (H₂O, CO₂, CH₄, etc.), for improving the prediction of the gases, and for modeling atmospheric dynamics and climate change. The methodology also should be applicable to identification of chemical agents for homeland security applications. Commercial applications would include gas-leak

sensing of pipelines, fire detectors for commercial and private aircraft, combustor feedback control sensors, and process control sensors for energy and chemical production industries.

Nanowire Optical Assay Probe (DOE 2006 SBIR Phase 2)

Youssef M. Habib, Principal Investigator, joe.habib@illuminex.biz

Illuminex Corporation, Lancaster, PA; 717-871-8971

DOE Grant No. DE-FG02-05ER84282

Period of performance: NA

Amount: \$750,000

Nanotechnology-enabled probes, which can interact with and sense biological compounds on the molecular level, hold great promise for point-of-care diagnosis of disease. This project will develop a nanowire optical probe that uses surface enhanced Raman scattering (SERS) as a method for molecular identification. The probe will be incorporated into a portable, rapid, and highly sensitive assay system that will detect multiple biomedical substances in patients. In Phase I, a nanowire optical probing platform was successfully engineered. Antibodies for the ovarian cancer marker CA 125 were used to characterize the sensor platform as to its optical, chemical, and biological properties. Phase II will expand the development of the nanowire optical assay probe, integrate the probe with diagnostic control systems, and perform clinical laboratory tests to compare the nanowire assay performance with standard clinical laboratory assays. Finally, a prototype diagnostic instrument will be produced. The nanowire assay probe should be able to identify virtually any antibody, offering the potential to replace hundreds of assays in clinical and research laboratories with a portable instrument. In addition, these probes could be configured to detect chemical and biological compounds in the environment.

Optical Carbon Dioxide Field Isotope Ratiometer (DOE 2006 SBIR Phase 2)

Jeffrey S. Pilgrim, Principal Investigator, jpilgrim@vistaphotonics.com

Vista Photonics, Inc., Santa Fe, NM; 505-466-3953

DOE Grant No. DE-FG02-05ER84306

Period of performance: NA

Amount: \$750,000

Anthropogenic greenhouse gas emissions are best quantified by determining their carbon dioxide isotope ratios; however, the required precision represents a challenge to optical measurement techniques under field deployment conditions. This project will develop a compact, rugged, mid-infrared spectrometer capable of determining isotopic carbon dioxide ratios at atmospherically relevant levels. In Phase I, a mid-infrared spectrometer for the detection of carbon dioxide at 4.3 microns was constructed, based on a pulsed quantum cascade laser (QCL). The sensitivity, selectivity, and precision of the instrument for isotopic carbon dioxide analysis were determined by using a high-performance optical cell specifically suited for QCLs. An isotopic abundance measurement precision below 0.2 'per mil' was predicted. In Phase II, a fully-integrated QCL sensor prototype, based on photoacoustic spectroscopy, will be constructed for field determination of atmospheric CO₂ isotope ratios. Standard operating protocols for the sensors will be established. The prototypes will be refined through field-testing in several applications, which also will be Phase III commercialization opportunities. The instrument

should provide a compelling blend of price, performance and physical advantages in a variety of gas detection applications. Examples include atmospheric monitoring, environmental regulatory compliance, process gas analysis, and biomedical breath diagnostics.

Ormosil Nanocomposite-Based Unattended, Field-Deployable and Reversible Optical Sensor for Atmospheric Carbon Dioxide (DOE 2006 SBIR Phase 1)

Kisholoy Goswami, Principal Investigator, kisholoy.goswami@innosense.us

Innosense, LLC, Torrance, CA; 310-530-2011

DOE Grant No. DE-FG02-06ER84417

Period of performance: NA

Amount: \$100,000

The prediction of carbon sources/sinks, using the atmospheric carbon dioxide inversion method, is currently limited by the availability of high-precision carbon dioxide measurements, which in turn is constrained by high instrument cost and maintenance difficulties. This project will remove the bottleneck by developing a simple, inexpensive, and longer-lasting carbon dioxide sensor that not only is suitable for autonomous measurements in the field but also exhibits specifications that match larger and expensive research instruments. Phase I will establish feasibility by constructing a working model of the device. High signal-to-noise ratio will be obtained by utilizing ratiometric measurements for achieving a resolution of 1 part in 3000 or better. Sensor performance will be characterized with respect to long-term drift, sensitivity, accuracy, resolution, and lack of interference from smog components, such as sulfur dioxide. An autonomous system for long term deployment would be applicable to DOE's ecological and environmental research programs for measuring greenhouse gases in media such as the atmosphere, biosphere, soil and ocean water. The sensor platform also should be adaptable to the analysis of other trace gases (e.g., ammonia, oxides of nitrogen and sulfur, and carbon monoxide) when appropriate indicators are incorporated. Commercial arenas for the technology include trace gas monitoring, pollution monitoring, and industrial process monitoring.

Portable NMR Spectrometer (with Magnet) (DOE 2006 SBIR Phase 2)

John L Delayre, Principal Investigator, jld@tecmag.com

TECMAG, Inc., Houston, TX; 713-667-8747

DOE Grant No. DE-FG02-05ER84174

Period of performance: NA

Amount: \$746,480

Nuclear Magnetic Resonance (NMR) is a powerful, non-destructive spectroscopy technique used to investigate chemical structure. NMR offers many opportunities for qualitative identification and quantitative analysis of both organic and inorganic components of suspect materials, such as solvents, raw materials, and waste materials. This project will develop a portable instrument for the identification and analysis of these suspect materials. Analyses can be done on unprocessed samples, or by addition of a solvent, metal-complexing agent, indicator, or other test reagent, as appropriate. In Phase I, a portable NMR spectrometer console (8.5" x 11.5") was developed. During Phase II, a smaller size console will be developed, along with portable permanent magnets needed to complete the instrument. The portable NMR instrument

should have widespread applications, not only for on-site nonproliferation inspections, but also for forensics, the pharmaceutical industry, and the detection of chemical and biological weapons.

Real-Time Infrared Greenhouse Gas Sensor (DOE 2006 SBIR Phase 1)

Hans-Jurg Jost, Principal Investigator, hjjost@novawavetech.com

Novawave Technologies, Inc., Redwood City, CA; 650-610-0956

DOE Grant No. DE-FG02-06ER84424

Period of performance: NA

Amount: \$99,999

Improved trace-gas monitors are needed for monitoring fluxes and concentrations of trace greenhouse gases such as methane. This project will develop such a sensor based on a novel mid-infrared laser source. The laser will possess many desirable qualities, including high reliability, excellent beam quality, compact size, low power consumption, and room-temperature single-frequency operation. The laser will be combined with a rugged, miniaturized gas sampling system to enable long-term measurements of trace gas fluxes and concentrations in field settings. During Phase I, the mid-infrared laser source will be constructed and fully characterized. The source will be used in conjunction with a compact gas sampling system to demonstrate the fast and accurate determination of methane concentrations in atmospherically relevant gas mixtures. Preliminary designs for a fully automated Phase II sensor will be produced. Commercial applications are expected in a variety of industrial process control settings, e.g., trace gas monitoring, greenhouse gas monitoring for emissions compliance, and hydrocarbon leak detection.

Real-Time, Ultrasensitive Ammonia Sensor (DOE 2006 SBIR Phase 1)

Hans-Jurg Jost, Principal Investigator, hjjost@novawavetech.com

Novawave Technologies, Inc., Redwood City, CA; 650-610-0956

DOE Grant No. DE-FG02-06ER84423

Period of performance: NA

Amount: \$99,998

Ammonia is the dominant species in the troposphere, and is known to rapidly associate with various acidic compounds to form aerosols. Detection of NH₃ at ppt to ppb concentration levels is still difficult to achieve with established methods, especially with the added requirement that the temporal resolution be adequate for a number of atmospheric correlation studies. This project will develop a fully automated instrument that can accurately monitor ammonia with ppb resolution in 1 second. This will be accomplished by developing a new, fieldable spectrometer that is based on combining a recently available solid state laser source with an ultra-sensitive spectroscopic detection method. In Phase I, the core sensor breadboard system will be constructed, tested, and used to perform measurements on ammonia samples. Additionally, optimum spectral transitions for ammonia monitoring will be identified, and a fast response sampling system will be designed. Designs for a ruggedized Phase II system will be identified. The markets for continuous ammonia monitoring systems include emissions monitoring, atmospheric research, and cooling-system leak detection.

Refractometric Porous Polymeric Ammonia Sensor (DOE 2006 SBIR Phase 1)

Fang Zhang, Principal Investigator, sutama@poc.com

Physical Optics Corporation, Photonic Systems Division, Torrance, CA; 310-320-3088

DOE Grant No. DE-FG02-06ER84425

Period of performance: NA

Amount: \$99,985

Ammonia, the primary atmospheric base, plays a crucial role in determining the acid-neutralizing capacity of tropospheric air masses, as well as in the nucleation, growth, composition, and chemistry of aerosol particles, which are linked with environmental degradation and human health problems. Fast measurement of ammonia is rated as the highest DOE measurement priority because it is critical to advancing the understanding of aerosol evolution and to supporting a strategy of sustainable and pollution-free energy. This project will develop a low-cost, highly sensitive, refractometric, porous, polymeric ammonia sensor for airborne-based field campaigns. The new sensor will measure ammonia quickly and cost effectively in real time. Phase I will determine the technical feasibility through computer modeling of major device components and through the analysis of physical processes within the complex device. The engineering foundation for the full-scale development of the optical sensor, along with related polymer coating technologies, will be established. A hardware prototype will be built to demonstrate feasibility. Commercial applications would include leak detectors for natural gas and industrial refrigeration facilities and monitors for measuring ammonia in smokestack emissions. The proposed new sensor also could be adapted for such applications as air monitoring, homeland defense, smart-building monitoring, and water quality and environmental monitoring.

Software Tools for Full Spectrum Analysis of Hyperspectral Data (DOE 2006 SBIR Phase 1)

Michael E. Winter, Principal Investigator, winter@higp.hawaii.edu

Technical Research Associates, Inc., Honolulu, HI; 858-539-0912

DOE Grant No. DE-FG02-06ER84642

Period of performance: NA

Amount: \$99,902

Current hyperspectral analysis, used to extract information related to nuclear fuel cycle signatures, relies on principal component and matched filter processing, which may not fully exploit all of the information in the data. This project will develop an innovative method for (1) using Independent Component Analysis (ICA) as a means to find end-members, which will serve as an alternative to principal components, (2) adding rule-based spectroscopic methods as an alternative to matched filter processing, and (3) assembling the tools in a user-friendly software package. The approach will be based on a previously-developed N-FINDR end-member determination and unmixing package, along with an associated microcorder spectral-identification tool. In Phase I, the requirements for the new tools, to supplement principal components and matched filter, will be analyzed. The N-FINDR Visualization Package will be modified to include ICA. Finally, LWIR spectra will be incorporated, and the requirements for gas identification using these spectroscopic techniques will be determined. The efficient and accurate determination of spectral end-members should lead to a number of commercial remote sensing application for hyperspectral sensors, including mineral exploitation, agriculture, product inspection, and other types of monitoring.

Spectroscopic Measurement of Carbon Isotope Ratios in Methane (DOE 2006 SBIR Phase 1)
David Christian Hovde, Principal Investigator, dchovde@swsciences.com
Southwest Sciences, Inc., Santa Fe, NM; 505-984-1322
DOE Grant No. DE-FG02-06ER84435
Period of performance: NA
Amount: \$100,000

Concentrations of methane in the atmosphere have increased 150% in the past three centuries, and accurate measurements are needed to characterize the sources of this greenhouse gas. Isotope measurements are a candidate technology, but existing measurement approaches are cumbersome, and require that samples be collected and returned to a lab for analysis. This project will use a near-room-temperature, infrared diode laser to probe strong transitions of methane, including ^{12}C and ^{13}C isotopes. The laser will be combined with compact optics and digital signal processing to achieve high precision measurements of isotope ratios. Phase I will characterize the laser source (including its wavelength, spectral bandwidth, power, and tuning) as a function of current and temperature, integrate it into a spectrometer based on a proprietary optical cell, and use it to measure the carbon isotope ratio of methane in air. The target sensitivity is the measurement of isotope ratios with a precision between 0.1 and 1 parts per thousand. An instrument for measuring methane isotope ratios should have application for the atmospheric sciences, providing lower cost, greater portability, and longer time between servicing. Other applications would include the detection of leaks in the natural gas distribution network and the monitoring of on-site production at natural gas wells.

Temperature Programmed Thermal Desorption Aerosol Mass Spectrometry (TPTDAMS) for Determining Organic Aerosol Composition (DOE 2006 SBIR Phase 1)
John T. Jayne, Principal Investigator, jayne@aerodyne.com
Aerodyne Research, Inc., Billerica, MA; 978-663-9500
DOE Grant No. DE-FG02-06ER84410
Period of performance: NA
Amount: \$99,999

An innovative aerosol mass spectrometer has been developed that can provide size-resolved, quantitative chemical composition data on aerosol particles. In this project, the aerosol mass spectrometer technology will be combined with a temperature-programmed thermal-desorption process that separates organic compounds based on volatility. The combined technology will provide a powerful new tool for in situ time-resolved measurements of the chemical composition of organic-containing particulate matter. Phase I will (1) design and construct a temperature-programmed thermal-desorption module and integrate it into the aerosol mass spectrometer; (2) conduct laboratory testing and evaluation of the combined technology; (3) evaluate the combined technology with several different ionization methods, including vacuum ultraviolet photoionization and Lithium ion attachment, and (4) design a prototype instrument to be constructed in Phase II. The proposed instrument should provide a powerful new tool for detailed measurements of the chemical composition of aerosol particles. The instrument could be employed in ambient pollution monitoring, in chemical and biological warfare agent identification, and in the characterization and control of aerosol emissions from a variety of industrial and energy production processes that produce aerosol-laden gaseous exhaust or waste streams.

Time-Lapse 3D GPR Characterization and Monitoring of Near-Surface Groundwater and Contaminant Flows (DOE 2006 SBIR Phase 2)

David E. Lumley, Principal Investigator, david.lumley@4thwaveimaging.com

4th Wave Imaging Corporation, Aliso Viejo, CA; 949-916-9787

DOE Grant No. DE-FG02-05ER84266

Period of performance: NA

Amount: \$750,000

This project will develop technology that uses ground-penetrating radar to image groundwater contaminant plumes underground and to monitor them in time-lapse mode as they undergo natural biodegradation or are cleaned up by remediation processes. The technology would enable engineers to monitor the effectiveness of clean-up operations in real time, make adjustments to remediation processes if necessary, and to locate any residual contaminants before leaving the site. In Phase I, prototype methods and software algorithms were developed for processing time-lapse radar data; images and quantitative estimations of underground contaminant-saturation distributions were produced; and the feasibility of imaging groundwater contaminants--in the presence of rocks, water, contaminants, and radar noise--was demonstrated. In Phase II, a field trial will be performed at a DOE/DoD contaminant site undergoing active biodegradation or remediative clean-up of groundwater contaminants.

Tunable Infrared Quantum Cascade Lasers for Active Electro-Optical Remote Sensing (DOE 2006 SBIR Phase 1)

Timothy Day, Principal Investigator, tday@daylightsolutions.net

Daylight Solutions, Inc., Poway, CA; 858-391-0377

DOE Grant No. DE-FG02-06ER84631

Period of performance: NA

Amount: \$99,999

The remote monitoring and detection of airborne effluents from nuclear fuel cycle processes are needed to verify nonproliferation agreements. Mid-infrared (IR) light, with wavelengths from 3 to 14 μm , could be used to characterize absorption patterns and would greatly facilitate the identification of these chemicals. At present, there is no robust and reliable way to generate an intense beam of mid-IR light that can be tuned by wavelength to look for these absorptions. This project will design and build a high-power, tunable mid-IR laser for use in remote sensing applications. State-of-the-art quantum cascade laser (QCL) technology will be incorporated in a miniaturized tunable-laser cavity to provide a field-ready, mid-IR light source, enabling the detection of airborne chemicals. Phase I will extend current QCL fabrication technology to develop materials suitable for incorporation in a miniaturized tunable-laser cavity. Tunable, near-IR diode-laser technologies will then be extended to the mid-IR to enable design and construction of a miniaturized tunable laser using these new QCL materials. Two prototypes of a tunable mid-IR laser that meet the remote sensing requirements will be produced.

Two Dimensional Chromatography of Atmospheric Aerosols: A New In Situ Instrument (DOE 2006 STTR Phase 2)

Susanne V. Hering, Principal Investigator, Susanne@aerosol.us

Aerosol Dynamics, Inc., Berkeley, CA; 510-649-9360. Partnered with University of California, Berkeley

DOE Grant No. DE-FG02-05ER86235

Period of performance: NA

Amount: \$749,995

Organic matter is a major constituent of airborne particles, comprising 20-50% of their mass. Identification of the components is critical for tracing sources, elucidating transformation and formation processes, assessing affects on human health, and assessing affects on global climate; hence, in situ, high-time-resolution comprehensive measurements of organic aerosol speciation are required. In previous work, a thermal-desorption aerosol gas-chromatography (TAG) mass spectrometer (MS) was developed, which provides identification and quantification of organic constituents at the molecular level, with hourly in situ measurements. Although many compounds can be identified with TAG, a significant portion of the material eluting from the single dimension chromatography column is not separated. This project will improve the chromatographic resolution of the TAG by using two-dimensional (2D) chromatography, thereby allowing a vastly increased number of individual organic species in ambient aerosols to be measured. Phase I successfully incorporated a 2D chromatography system onto the existing 1D-TAG system. A considerable improvement in the separation of organic compounds, in both complex standards and ambient aerosols, was demonstrated. The 2D-TAG was able to separate more than 6 times as many compounds as the 1D-TAG. In Phase II, a fast mass spectrometry capability will be added to the 2D-TAG, and the chromatography will be refined to enhance the separation of individual organic compounds. The complete 2D-TAG-MS system will be tested, along with traditional filter-based methods and a variety of complementary measurement systems.

Beyond the on-line chemical analysis of aerosols for atmospheric research, the technology should be applicable to drug manufacturing and to the detection of biological or chemical agents.

An Ultra-Precise System for Electrical Resistivity Tomography Measurements (DOE 2006 SBIR Phase 2)

Douglas J. LaBrecque, Principal Investigator, dlabrecque@mpt3d.com

Multi-Phase Technologies, LLC, Sparks, NV; 775-425-9606

DOE Grant No. DE-FG02-05ER84289

Period of performance: NA

Amount: \$493,755

One of the most widely used geophysical methods for monitoring flow within the shallow subsurface is electrical resistivity tomography (ERT). The latest generation of ERT systems can monitor data to a precision of around 1%, allowing in situ changes to be interpreted within a few percent. In turn, subsurface temperature changes can be monitored to within a few degrees Centigrade, low levels of tracers--only slightly higher than background variations--can be tracked, and fracture propagation on a site of several thousand square meters can be watched. This project will make improvements to hardware and data collection procedures that will raise ERT precision by an order of magnitude. In Phase I, modifications were made to interdependent

hardware and software systems, resulting in reductions in both random and systematic noise sources. Random noise was reduced by implementing longer data averaging periods and by improving stacking algorithms. Systematic noise was reduced by improving hardware design, including the isolation of transmitter and receiver paths in the multiplexer and the use of temperature-stabilized higher-precision components to improve calibration. Electrode and cable effects also were found to be larger sources of noise than anticipated. Phase II will investigate the use of alternative materials for the electrode and cable to mitigate the noise from these sources. Alternative data collection strategies will be investigated. Improvements to hardware and software will focus on calibration. Field trials will be held in difficult environments, such as Idaho National Lab's Box Canyon fractured rock study area and Vadose Zone Research Park. An improved ERT technology should increase measurement precision, increase resolution, and enhance effectiveness in existing monitoring applications without significantly increasing costs. These improvements should broaden the range of applications for the method, particularly in monitoring flow in the shallow subsurface.

Universally Networked Sensor for Carbon Dioxide Measurement (DOE 2006 SBIR Phase 1)
Evgeni Poliakov, Principal Investigator, sutama@poc.com
Physical Optics Corporation, Electro-Optics and Holography Division, Torrance, CA; 310-320-3088
DOE Grant No. DE-FG02-06ER84426
Period of performance: NA
Amount: \$99,997

Accurate, universal measurement techniques are needed for the in situ monitoring of carbon dioxide in large ecosystems. This project will develop an inexpensive (about \$500), extremely efficient (about 25 microwatts), robust, scalable wireless network of individual, accurate (0.5 part per million) carbon dioxide sensors. The network will be suitable for remote operation and will run for months on two standard AA batteries. The wirelessly interrogated sensors, which would be 1-2 kilometers apart in open areas, will be integrated into a simple network and will report to a ground-based or airborne network manager that collects the data from numerous sensor nodes. Phase I will establish the feasibility of this next-generation sensor network system through an experimental proof-of-concept demonstration based on inexpensive optical components, standardized electronics, and wireless interfaces. Specifically, a carbon dioxide optical-sensor breadboard will be developed in the laboratory to demonstrate sensor sensitivity of 0.5 ppm or better, while using low power sensor network electronics and wireless communication. The new scalable wireless network of sensitive sensors should provide more versatile measurements and significantly better quantification of carbon dioxide sequestration. The network's scalability and efficiency should form a solid base for developing other wireless sensors in the chemical, mining, steel, energy-producing, and waste-management industries, and in agricultural and environmental monitoring.

UV Solid-State Laser for Proliferation Detection (DOE 2006 SBIR Phase 2)

Paolo Zambon, Principal Investigator, paolo.zambon@aculight.com

Aculight Corporation, Bothell, WA; 425-482-1100

DOE Grant No. DE-FG02-05ER84135

Period of performance: NA

Amount: \$750,000

Compact laser systems are needed to interrogate possible sites of nuclear proliferation that, for strategic or political reasons, cannot be sampled and inspected directly. This laser system would be used with a nonlinear optical wavelength converter for remote spectroscopic analysis of effluents from suspected sites. This project will develop an advanced laser system that will be compact, lightweight, efficient, and suitable for deployment on a UAV. The laser system will be based on Yb:S-FAP, a relatively novel laser material with an upper state lifetime more than five times longer than Nd:YAG. For this particular application, the increased lifetime translates into a fivefold reduction in the number of pump diodes, leading to a more cost-effective and compact laser system. In Phase I, a full-scale, diode-pumped, Yb:S-FAP gain module was designed, fabricated, and tested. The module provided an output over 400 mJ in long-pulse quasi-cw operation as an oscillator, and a single-pass small signal gain of $G_0 = 7.6$ ($g_0 = 2$ nepers) in an amplifier configuration. A detailed analysis, along with the experimental results, showed that the approach was likely to meet the 200 mJ/pulse energy requirement. In Phase II, Yb:S-FAP slabs will be procured, and the system will be built and tested. The laser system will be configured into a rugged package suitable for airborne deployment. Diode pumped solid-state lasers are used extensively in materials processing and other high value commercial applications, but these lasers have not achieved significant market penetration in high pulse energy (> 100 mJ) laser markets currently dominated by excimer and lamp pumped solid-state lasers. Despite their significant advantages, the use of diode pumped solid state lasers has been limited by the high cost of the diode laser pump sources. By using Yb:S-FAP, the diode cost (the main cost driver in high pulse energy systems) should be reduced by a factor of 4 to 5, compared with an Nd:YAG laser, resulting in a cost-effective solution for a wide range of commercial applications.

U.S. Environmental Protection Agency

Acrolein Monitor Using Quantum Cascade Laser Infrared Adsorption (EPA 2006 SBIR Phase 1)

Joanne H. Shorter, (978) 663-9500 x208, shorter@aerodyne.com

Aerodyne Research Inc., Billerica, MA

EPA Contract Number: EPD06020

March 1, 2006 through August 31, 2006

Project Amount: \$70,000

Acrolein has been identified by the U.S. Clean Air Act as a hazardous air pollutant because of its adverse health effect, particularly on respiratory systems. There are both anthropogenic and natural sources of acrolein in the environment. Acrolein is produced by combustion sources (e.g., vehicle exhaust, prescribed agricultural burning, cigarette smoke) and industrial sources, including manufacturing facilities of wood products. There is, however, limited data quantifying the emissions of acrolein from these sources. There also are few reports

of ambient levels because of the measurement limitations. U.S. EPA Region 10 has identified as a priority issue the development of a measurement technique for monitoring acrolein. Aerodyne Research, Inc., proposes to develop a fast-response, novel, quantum-cascade laser system based on tunable infrared laser differential adsorption spectroscopy (TILDAS). The diversity of sources and the relatively high reactivity of acrolein require a highly sensitive, easily portable, and fast-response measurement technique. The proposed acrolein monitor will meet these requirements, achieving sensitivities both in the parts-per-billion range for source monitoring and parts-per-trillion range for ambient monitoring. The objective of this Phase I research and development effort is to determine the feasibility of a real-time, mid-infrared TILDAS instrument to monitor acrolein. Aerodyne will evaluate potential infrared spectral regions to determine the optimum region for acrolein monitoring. Aerodyne also will investigate background suppression techniques that are critical to achieving low detection limit. The Phase II instrument design will be identified in Phase I. The anticipated result of Aerodyne's approach is a robust, sensitive, real-time monitor of acrolein. It will be capable of long-term operation in the field or laboratory with minimal maintenance.

Balloon Platforms for Remote Sensing of Water Quality in Mixing Zones (EPA 2006 SBIR Phase 1)

Robert L. Doneker, (503) 222-1022, doneker@mixzon.com

MixZon, Inc., Portland, OR

EPA Contract Number: EPD06049

March 1, 2006 through August 31, 2006

Project Amount: \$69,993

MixZon, Inc., hypothesizes that lightweight infrared (IR) and video cameras mounted on an unmanned tethered helium balloon accessible via a wireless network can remotely sense water quality at site scales. MixZon will demonstrate the technical feasibility of a ground-based network to monitor and control balloon-mounted, IP-enabled wireless IR and video cameras for measurement of the spatial distribution of surface water temperature within the mixing zone. The mixing zone is the area where the initial dilution of a point source discharge occurs. This technology has immediate application to provide geospatial data for regulatory management and simulation model development and validation. Mixing zones are an important component of the National Pollutant Discharge Elimination System (NPDES) point-source discharge permitting process within total maximum daily load (TMDL) water quality management programs. MixZon will focus on mixing zones in rivers, where vertical mixing of point-source discharges is rapid and may be exhibited downstream for long distances, resulting in full lateral mixing. MixZon will integrate existing technology to demonstrate the rapid deployment of small balloon-mounted detectors to monitor mixing zones of industrial discharges. A balloon has a number of advantages over existing platforms for remote sensing of water quality. Existing platforms for remote sensing of water temperature at the site have limited availability, high costs, and long lead times to schedule deployment. The cost of a balloon platform is likely to be one-thirteenth to one-tenth the cost of the fixed-wing and helicopter alternatives, respectively. In addition, a low-cost balloon platform could be deployed on short notice by one to two people with minimal operator training and would be suitable for monitoring at fixed locations for longer time periods than is practical for current airborne sensors. Though water temperature is an important TMDL parameter in itself, temperature often can be used as a tracer to indicate the dilution and spatial

distribution of other important TMDL water quality parameters, such as sediment and coliform, which may occur within a mixing zone. Though MixZon will focus only on detecting temperature as a water quality parameter, there is the potential to monitor the fate and transport of other discharge constituents, including shoreline recreational exposure to pathogens from wastewater discharges, determination of the spatial extent of contaminated sediment deposits from mining operations, the impact of contaminated groundwater interaction within groundwater/surface recharge zones, and analysis of thermal refugia habitat for endangered species management.

A Compact, Low-Cost, Near-UV Sensor for Chlorine Dioxide (EPA 2006 SBIR Phase 1)

David S. Bomse, (505) 984-1322, dbomse@swsciences.com

Southwest Sciences, Inc., Santa Fe, NM

EPA Contract Number: EPD06057

March 1, 2006 through August 31, 2006

Project Amount: \$70,000

Southwest Sciences proposes the development of an optical, near-ultraviolet chlorine dioxide (ClO₂) sensor having a measurement range of about 0.01 to 2000 ppm with a response time of less than 10 seconds. The sensor will be compact--about the size of a 1-quart milk carton including electronic and optics, operate at low power, and be outfitted with a wireless communications interface to permit remote, unattended operation. Intrinsically safe design is possible. The proposed measurement method is linear, free of hysteresis, and free of interference from common atmospheric gases, as well as urban and industrial pollutants. The sensors will operate well at high humidity and will be able to tolerate moisture condensation. Analyzers will retain calibration for extended periods (many months). Commercial applications include real-time sensors for monitoring and controlling ClO₂ decontamination of buildings and other enclosed spaces and for monitoring ClO₂ water purification processes and facilities. In Phase II, Southwest Sciences will try to extend the diode-laser method to chlorine detection, which will provide extra utility for characterization and for monitoring combined ClO₂/Cl₂ decontamination and purifications processes. Southwest Sciences also plans to participate in the U.S. EPA Environmental Technology Verification Program to establish performance specifications for the prototype analyzer.

Development of Antibodies for the Detection of the Toxin Anatoxin by Immunoassay (EPA 2006 SBIR Phase 1)

Fernando M. Rubio, (215) 957-6477

Abraxis, LLC, Hatboro, PA

EPA Contract Number: EPD06014

March 1, 2006 through August 31, 2006

Project Amount: \$70,000

Fresh water cyanobacteria algal blooms potentially have many adverse environmental impacts. For instance, bloom mats of filamentous algae are believed to reduce ambient light levels below those required for submerged aquatic vegetation to survive. Blue-green algae form blooms that make a surface scum and have been associated with low levels of dissolved oxygen that can be lethal to fish and invertebrate species. In addition to the overt environmental impact,

blue-green algae blooms also can produce significant quantities of natural toxins. The toxins produced by these cyanobacteria are extremely toxic to many species. Cyanobacterial toxins (anatoxin-a, microcystins, saxitoxin) also have been identified as potential biological weapons. If these toxins were to be introduced into our water systems, they could not be removed efficiently by conventional water treatment systems and potentially could kill many people. Anatoxin-a also is known as "the very fast death factor" (LD50 for mice is 200 mg/kg with 4-7 minute survival); wild and domestic animals poisoned through ingestion have been observed in the field to be staggering, gasping, and suffering convulsions, followed by death within minutes to hours. Current analytical methods for quantifying the concentration of cyanobacterial toxins in water and in biomass include the mouse bioassay, high-performance liquid chromatography, and the phosphatase inhibition assay. Some of these methods are not sensitive enough or require the use of many animals. Although chromatographic methods are capable of detecting and identifying compounds, these methods are time-consuming, labor-intensive, and use flammable and/or toxic solvent for sample extraction. Faster, more sensitive, and less expensive analytical methods, such as enzyme-linked immunosorbent assay (ELISA) for the detection of cyanobacterial toxins, are ideal for the establishment of efficient and cost-effective screening programs that could be used onsite without the use of solvents in water samples. ELISA allows more precise prophylactic and corrective treatment of water at treatment facilities, ultimately benefiting the environment and public health. This Phase I research focuses on creating polyclonal antibodies and hybridoma cell lines that produce monoclonal antibodies. These antibodies react with anatoxin-a with sufficient selectivity, affinity, and avidity to be utilized in a commercial immunoassay system. Once these antibodies are available, commercial immunoassays to detect the cyanobacterial toxin in water and other environmental matrices will be developed and validated (Phase II).

Development of a Reliable, Low-Cost, and User-Friendly Spot Test Kit for Leaded Paint and Dust Based on Recent Advances in Bionanotechnology (EPA 2006 SBIR Phase 1)

Juewen Liu, jliu2@uiuc.edu

DzymeTech, Inc., Champaign, IL

EPA Contract Number: EPD06040

March 1, 2006 through August 31, 2006

Project Amount: \$70,000

Lead in household paint and dust is a serious health hazard, as low-level lead exposure can result in adverse health effects, especially in children. On-site and real-time detection and quantification of lead in paint/dust are very important to homeowners and certified lead-based paint removal professionals. DzymeTech, Inc., proposes to develop a reliable spot-test kit based on patented and patent-pending technologies developed by Dr. Yi Lu's group at the University of Illinois, Urbana-Champaign (UIUC). Dr. Lu has taken advantage of recent advances in bionanotechnology and has developed catalytic DNA-gold nanoparticles colorimetric sensors for lead. The sensor is highly sensitive and selective. A unique feature of the sensor is that the detection range can be tuned to match the idealized response for lead defined by HUD or EPA. Results from the Lu group also showed that the sensors have a long shelf life and are cost-effective. To achieve the objective of developing a reliable, low-cost, and user-friendly spot-test kit, DzymeTech will investigate methods for efficient dust sample collection, lead extraction, and applications of the colorimetric lead sensors under different conditions. Both simulated and real lead dust samples will be used for the test kit evaluation. Factors that improve user-

friendliness, shelf-life, and cost-effectiveness of the test kit will be evaluated. Several kits will be designed to reveal the sharpest color change as it occurs at dust lead hazard, clearance levels for floors, interior window sills, and window troughs. Phase I will determine the feasibility of transforming the concept developed at UIUC into a commercial product at DzymeTech. It also will lay a solid foundation for a large-scale test, validation, and further development of the spot-test kit in Phase II. Combined efforts in both phases will result in commercialization of a reliable kit to be used by both homeowners and lead removal professionals.

Field Analytical Method for Perchlorate (EPA 2006 SBIR Phase 1)
Richard H. Smith, (734) 995-9338, rsmith@sphinx.biosci.wayne.edu
IA, Inc., Ann Arbor, MI
EPA Contract Number: EPD06043
March 1, 2006 through August 31, 2006
Project Amount: \$70,000

Perchlorate is a widely used component of solid fuel, missile and rocket propellants, explosives, and pyrotechnics. It has been shown to reduce iodide uptake into the thyroid gland. The U.S. EPA has found perchlorate contamination in 18 states and believes contamination may exist in as many as 39 states. In early January 2005, the National Academy of Sciences, in an EPA-sponsored study, recommended a reference dose (RfD) for human ingestion of 0.7 ug/kg/day, which suggests a maximum contaminant level (MCL) of 24.5 ug/L (ppb) or lower; several states allow between 1 and 6 ug/L. Based upon this recommendation, there is a need for field monitoring of perchlorate in ground and surface waters to test the effluent of remediation facilities and to determine soil cleanup levels. To provide a field analytical method, IA, Inc., has devised a technology that combines ion chromatography (IC), similar to that used in EPA Method 314, with specific perchlorate detection using a low detection limit ion-selective electrode (ISE). Use of the perchlorate ISE as the detector results in lower interference from common anions than is found using Method 314. For this method, IA received a patent in 2004 (U.S. Patent No. 6,736,958). This method simplified and improved Method 314, as the ISE replaced both the conductivity detector and the suppression unit. It also improved the approach of measuring perchlorate by ISE, because the presence of sufficiently high levels of competing ions, measured without separation, can yield false-positive results. The innovation of this Phase I research is to simplify and standardize electrode construction by casting the electrode on thin-walled, porous tubing after having defined free space. The objectives are to (1) cast electrodes on a selection of porous tubing, selecting one that provides optimum robustness and reproducibility; (2) optimize electrode response by selecting the ionophore, plasticizer, and other ISE components; and (3) determine the selectivity obtained when using the perchlorate ISE as the detector for IC. Phase II will focus on optimizing calibration, developing analytical software, and field testing a prototype instrument. The resulting instrument will be suitable for field use, adaptable to batch analysis in the laboratory, and capable of remote sensing. Potential markets include U.S. Department of Defense contractors, environmental engineers and testing laboratories, state and municipal water authorities, and remediation firms.

Field Rugged, Portable H₂O₂ Monitor (EPA 2006 SBIR Phase 1)
Michael B. Frish, (978) 689-0003
Physical Sciences Inc., Andover, MA
EPA Contract Number: EPD06051
March 1, 2006 through August 31, 2006
Project Amount: \$69,977

This Phase I SBIR project will support the development of a field-portable instrument for monitoring and controlling hydrogen peroxide (H₂O₂) concentration during building decontamination after accidental or purposeful exposure to hazardous biological materials. The goal of Phases I through III is to develop a product that enables accurate real-time H₂O₂ measurements over the concentration range of 1 to 10,000 ppmV. The envisioned product is an adaptation of a portable gas-sensing platform based on tunable diode laser absorption spectroscopy (TDLAS) technology. The sensors will offer a combination of sensitivity, specificity, fast response, dynamic range, linearity, ease of operations and calibration, ruggedness, and portability not available in alternative H₂O₂ detectors. Compared to other spectroscopic gas analyzers, TDLAS offers the benefit of probing individual spectra lines, rather than spectral bands. This capability will distinguish H₂O₂ from water, thus overcoming a cross-sensitivity that has limited the accuracy of other H₂O₂ analyzers. Phase I will provide the data needed to select the best H₂O₂ spectral features for these measurements, thereby establishing the feasibility of developing the novel H₂O₂ sensor. Phase I also will investigate means for creating simple devices for field verification of sensor operation, establish specifications for a commercial H₂O₂ sensor product, and develop conceptual designs. The initial application for the H₂O₂ sensor will be for building decontamination

A Membrane Preconcentrator for Portable Trace VOC Detectors (EPA 2006 SBIR Phase 1)
Haiqing Lin, (650) 328-2228, hlin@che.utexas.edu
Membrane Technology and Research Inc., Menlo Park, CA
EPA Contract Number: EPD06030
March 1, 2006 through August 31, 2006
Project Amount: \$69,994

The sensitivity of low-cost, portable volatile organic compound (VOC) detectors currently in use is low, which limits their application in many situations. More sensitive detectors are more expensive and less robust and not suitable for field use. This Phase I project involves the development of a membrane-based preconcentrator able to concentrate trace amounts of VOC contaminants to levels that can be measured easily by existing portable detectors. The membrane concentrator is simple, compact, and lightweight. Only a small vacuum pump and blower are required to power the unit. In the Phase I project, a prototype preconcentrator based on a new type of membrane will be constructed. The device will be operated with model VOC/air mixtures to demonstrate the overall feasibility of the approach. The system will be considered successful if it can concentrate part-per-billion levels of VOCs in air streams at least 100-fold. In Phase II, an integrated system consisting of the membrane preconcentrator and a suitable detector will be built and demonstrated. If successfully developed, the portable system will be used to determine VOC concentrations for environmental monitoring and for process control in chemical plants. The membrane concentrator component cost is not expected to be

more the \$5,000, so the improvement in performance of existing detectors will be achieved with only a small increase in total instrument cost.

On-Line, Near Real Time Water Security BioMonitoring System (EPA 2006 SBIR Phase 1)

Salvador M. Fernandez, (860) 528-9737

Ciencia Inc., East Hartford, CT

EPA Contract Number: EPD06038

March 1, 2006 through August 31, 2006

Project Amount: \$69,995

Ciencia, Inc., proposes to develop an innovative biosensor system for near real-time, on-line monitoring of water for the presence of pathogens and biotoxins. The proposed optical biosensing approach possesses a unique combination of features: (1) it does not require the use of labels for detection (such as fluorescent, enzymatic, or radioactive tags), which enables easy automation of immunoassays and direct real-time detection of analytes, and (2) it is microarray-based, thus providing for highly parallel detection of multiple analytes, including viruses, bacteria, spores, and biotoxins. Ciencia anticipates that the system will provide continuous monitoring with a sampling period of less than 1 hour and with a detection limit for bacteria on the order of one organism per mL. Potential commercial applications include environmental water testing and water supply security, biodefense and homeland defense, biomedical research, clinical diagnostics, agricultural bioterrorism, food safety testing, and environmental contamination and remediation.

Rapid Immunochromatographic Strip Tests Detecting Lead-Based Paint (EPA 2006 SBIR Phase 1)

Mark Geisberg, (626) 359-8441, mgeisberg@silverlakeresearch.com

Silver Lake Research Corporation, Monrovia, CA

EPA Contract Number: EPD06056

March 1, 2006 through August 31, 2006

Project Amount: \$69,990

Exposure to lead-based paint (LBP) is the major source of potentially dangerous levels of lead in children and adults in the United States. This project aims to develop rapid, on-site test kits for the detection of harmful levels of LBP. The proposed test kits will be calibrated to current regulatory standards, will require no user training or instrumentation, and will resemble a home pregnancy test. The proposed test kits will produce a yes/no result, with the negative result providing extremely high confidence that the sample does not contain lead in excess of the regulatory limit and the positive results informing the user that further testing may be warranted. The test kits will be designed to replace current instrument-based assay methods for screening purposes. The successful product will (1) increase the effectiveness and reduce the cost of large-scale screening and mapping of LBP contamination, and (2) enable nontechnical users to quickly and accurately detect or rule out LBP contamination at home or onsite. In Phase I, Silver Lake Research Corporation will attempt to develop a laboratory-format immunoassay for detecting lead extracted from paint chips. At the successful conclusion of Phase I, Silver Lake Research will have demonstrated an extraction-immunoassay procedure capable of discerning whether a given sample of paint contains lead in excess of the regulatory limit. In Phase II, Silver Lake

Research will transfer the immunoassay capability developed in Phase I into a rapid immunochromatographic test strip format. Silver Lake Research has been producing test strips of this type since 1998, and possesses considerable expertise in the design, development, and manufacturing of immunoassay test strips. All of these products share the principle of replacing costly, time-consuming, and labor-intensive analyses with a rapid and accurate screening test.

Real-Time Reagentless and Arrayed Detector for the Monitoring of Harmful Algal Bloom Toxins (EPA 2006 SBIR Phase 1)

Richard McAloney, (979) 693-0017, info@lynntech.com

Lynntech Inc., Bryan, TX

EPA Contract Number: EPD06047

March 1, 2006 through August 31, 2006

Project Amount: \$70,000

Harmful algal blooms (HABs) occur in aquatic environments when conditions trigger an increase in the abundance of organisms that produce toxins. The toxins are transferred through the food web where they affect and even kill zooplankton, shellfish, fish, birds, marine mammals, and possibly humans. HABs have been estimated to cost the United States as much as \$50 million per year as a result of the closure of fisheries, recreational waters and beaches, and the treatment of human illness from exposure to toxins. Early detection of blooms and rapid response to such events is the most effective way to mitigate the impact of HABs. The official methods to test for HAB toxins are the mouse bioassay and high-performance liquid chromatography. These methods are generally laborious, time-consuming, and require expensive laboratory equipment. Currently, there are no real-time, stand-alone monitoring devices to test for the presence of biotoxins from HABs. Lynntech will develop an inexpensive, rugged, reagentless, and real-time detection system for shellfish toxins in seawater. The versatility and arraying ability of the proposed technology will enable detection of a multitude of toxins and pathogens (e.g., cyanobacteria) in fresh or ocean water. Lynntech's proposed technology is based on diffraction-based sensing that utilizes the changes in diffracted light intensity upon the absorption of a target onto specific areas of a patterned surface of antibodies. The specific recognition and the use of diffraction detection eliminate the need for any secondary labeled-antibodies and reagents and are quantifiable. In Phase I, Lynntech will develop the proposed sensor technology for the detection of various brevetoxins from the dinoflagellate *Karenia brevis*, a common species associated with HABs. The subcontractor, Dr. Baden, from the University of North Carolina at Wilmington, is a brevetoxin expert and the major work supplier of brevetoxins and brevetoxin antibodies. In Phase II, an alpha generation system will be assembled and incorporated into the Texan Automated Buoy System in collaboration with Dr. Lisa Campbell from the Department of Oceanography at Texas A&M University. The main commercial application of this proposed research is for coastal monitoring of HAB biotoxins for health and safety. The technology is easily amenable to detecting pathogens, further enhancing the commercialization potential in the food safety and water monitoring markets.

Real-Time Transformer Oil Polychlorinated Biphenyl Sensor (EPA 2006 SBIR Phase 1)
Carl R. Evenson, (303) 530-0263
Eltron Research Inc., Boulder, CO
EPA Contract Number: EPD06035
March 1, 2006 through August 31, 2006
Project Amount: \$69,999

Though manufacturing of polychlorinated biphenyls (PCBs) was discontinued 30 years ago, PCBs remain a significant environmental threat. PCBs are toxic and suspected to be carcinogenic to humans. Because of the chemical and thermal stability of PCBs in the environment and the continued use of transformers containing these chemicals, very specific regulations are in place that require the quantification of PCBs in all transformer oil. The Toxic Substance Control Act has mandated that the concentration of PCBs in transformer oil be less than 50 parts per million. Analysis of PCB concentration is currently performed by ASTM standards in an analytical laboratory using gas chromatography. This type of analysis is time-consuming and costly. In addition, for this off-site analysis, oil must be removed from the transformer, which potentially exposes workers and the environment to PCBs. In this Phase I SBIR project, Raman spectroscopy and multivariate analysis will be used to create a rapid in situ sensor capable of simultaneous detection of PCB concentration and composition within transformer oil. A matrix of Raman spectra corresponding to specific concentrations and specific mixtures of PCBs will be collected and compiled using multivariate analysis software. Raman spectra will be collected using fiber optics and a submersible Raman probe. This will allow collection of Raman spectra without removing oil from the transformer. Chemometric models then will be created that will allow the determination of PCB concentration and type based on a single Raman spectrum of an unknown transformer oil sample. Once developed, this type of sensor will easily be modified for rapid detection of PCBs in a variety of different media.

A TEF-Based Dioxin Kit Utilizing Fluorescent Aptamers (EPA 2006 SBIR Phase 1)
Bharat Chandramouli, (919) 281-4040
Eno River Labs, LLC, Durham, NC
EPA Contract Number: EPD06031
March 1, 2006 through August 31, 2006
Project Amount: \$69,737

Eno River Labs, LLC, (ERL) proposes to develop an onsite testing kit for dioxins that uses fluorescently tagged ssDNA aptamers for selective binding and subsequent screening and quantitative analysis of dioxin in soil sample. Current dioxin field test kits are immunoassay-based, which are insufficiently specific and sometimes unreliable. Reliable dioxin testing requires laboratory tests, which can take days to weeks for results. The field test kit will provide rapid and easy to use for on-site quantitative testing for dioxin contamination. The kit will be based on the use of aptamers, which are specific binding nucleic acids that can be engineered to bind almost any compound with specificity and reliability. Aptamer mixes also can be designed to have different affinities to the different analytes of interest, hence a toxicity equivalency factor (TEF)-scaled kit is possible. In Phase I, ERL proposes to generate a set of specific fluorescent DNA aptamers to bind 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), the dioxin with the highest TEF. These dioxin-specific fluorescent aptamers will be developed by the systematic evolution of ligands by exponential enrichment (SELEX) technique. During development, the dioxin-

binding aptamers will be tested for their ability to bind specifically to 2,3,7,8-TCDD in the presence of other potential soil contaminants such as polychlorinated biphenyls (PCBs). In Phase II, ERL plans to define the standard curve for 2,3,7,8-TCDD, develop a TEF-scaled aptamer mix to screen for other toxic congeners, develop the quantitative parameters of ERL's kit, apply the dioxin-specific aptamers in a lyophilized form to be easily used in the kit, and demonstrate their utility for contaminated soil monitoring. ERL will test and validate the kit with U.S. EPA Method 1613B, using archived soil samples and performing the analysis in-house, thus obviating the need for field sampling. ERL's kit will be the first truly TEF-based kit available and will be useful for quick analysis onsite, thus providing a means of contamination monitoring, potential reduction in business risk, and more educated decision on modification in construction plans. ERL's onsite kit will offer a nontoxic environmentally friendly, fast, reliable test for dioxin contamination in soil.

Ultrasensitive Acrolein Sensor for Environmental Monitoring (EPA 2006 SBIR Phase 1)

Bruce Richman, (408) 962-3900

Picarro, Inc., Sunnyvale, CA

EPA Contract Number: EPD06023

March 1, 2006 through August 31, 2006

Project Amount: \$69,284

Picarro, Inc., will build a trace-gas sensor based on cavity ringdown spectroscopy (CRDS) targeting the acrolein absorption band at 1623 nm for environmental monitoring. Acrolein is a ubiquitous airborne pollutant. Its sources include burning vegetation (e.g., forest fires), waste incinerators, furnaces, fireplace, gasoline- and diesel-engine emissions, power plants, polyethylene combustion, cigarette smoke, and the cooking of food. Acrolein is extremely toxic to humans and is listed by the U.S. EPA as one of 33 hazardous air pollutants. Picarro intends to determine whether a sensor based on CRDS can be used to detect acrolein with a sensitivity of 1 ppb in the presence of H₂O, CO₂, CO, and other potential sources of interference in the atmosphere and in combustion exhaust. Picarro will measure the optical absorption spectrum of the 1623 nm band along with potential interferants. Picarro also will determine the performance characteristics of the sensor including precision, accuracy, linearity, and lower detectable limit.

Ultra Sensitive Raman Device for Detecting Arsenic in Water Utilizing Fractal/Microcavity Composite (EPA 2006 SBIR Phase 1)

Won-Tae Kim, (505) 524-3664

LaSys, Inc., Las Cruces, NM

EPA Contract Number: EPD06045

March 1, 2006 through August 31, 2006

Project Amount: \$69,997

Using the unique spectral characteristics of its proprietary fractal-microcavity composite, LaSys, Inc., will perform the proof-of-concept research required to develop an ultra-sensitive optical detector of low concentration of arsenic in water based on the Raman effect. The Phase I technical objectives are designed to demonstrate that fractal microcavity composite-surface-enhanced Raman scattering spectroscopy is capable of quantitatively detecting arsenic in water at

levels that are useful for determining compliance with the upcoming U.S. EPA maximum contaminant level (MCL) of 10 ug/L. The goal at the end of Phase III is to develop a hand-held, easy-to-use instrument for the field detection of arsenic at or below the January 2006 MCL. This ultra-sensitive instrument will provide accurate, precise, and quantitative measurement of arsenic in the 1 to 200 ppb range in real time via a visual digital readout. This commercial, field-portable device of robust construction will be battery powered and weigh approximately 1 pound and be simple to use in the hands of nontechnical individuals. It will provide significant advantages over currently available colorimetric test kits and chemical sensors and be competitively priced.