Success Posters

Success Posters address a problem area wherein a suite of technologies provides a solution to the problem, but are sometimes used for technology solution topics. This section includes seven Success Posters created by the EMSP to support National Workshops and various other presentations nationwide.

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Science Advancing Solutions

for Deactivation and Decommissioning

Metal Ion Analysis Using Near-infrared Dyes and the "Laboratory-on-a-Chip"

Principal Investigator:
Greg Collins
Naval Research Lab

Project Number:
64982

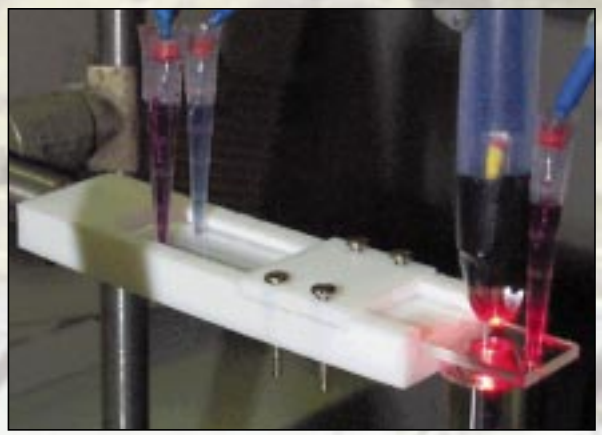
Science Category:
Analytical Chemistry & Instrumentation

Value to EM Cleanup:

- Quantification and identification of radionuclides and heavy metals, e.g., U, Pu, Cs, Sr, Hg, and Pb.
- Field portable for in-situ characterization.
- Rapid separation times, e.g., uranium characterized in less than a minute.
- Low volumes of secondary waste
- Low equipment cost.
- Low analysis cost

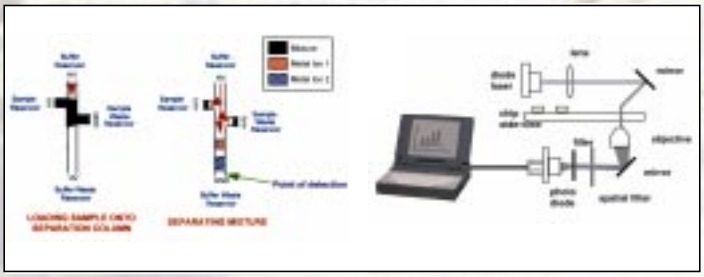
Accomplishments:

- Synthesis and purification of four, new fluorescence-tagged metal complexation ligands-cyclen, crown ether, iminodiacetic acid, and calix[6]arene.
- Demonstrated separation and quantitation of uranium on a microchip in less than a minute.
- Highly selective ligands or matrix components have been established for uranium detection
- Both absorbance and fluorescence detection modes have been demonstrated as sensitive modes of operation (ppb level detection limits) for uranium on a microchip.



Voltage is applied to the four reservoirs to transport ions and liquid down the microchannels.

Lab-on-a-chip showing microchannels and reservoirs



Through a process of electroosmosis and careful selection of applied voltages, metal on complexes are separated and identified by their differences in migration.

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For additional information visit the EMSP Website at
http://emsp.em.doe.gov

Environmental Management Science Program

Science Advancing Solutions

for Subsurface Contamination

Control of Biologically Active Degradation Zones by Vertical Heterogeneity: Applications in Fractured Media

Principal Investigator:
Frederick Colwell,
Idaho National Engineering and Environmental Laboratory

Project Number:
55416

Science Category:
Microbial Science

Value to EM Cleanup:

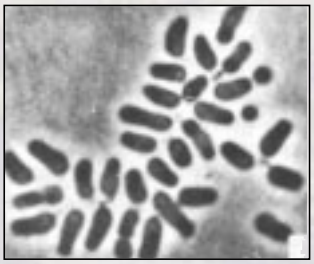
- The multi-level sampler provides an understanding of the chemical and microbiological conditions at specific vertical locations in the subsurface.
- A better understanding of subsurface chemical and microbial conditions helps identify potential in situ treatment solutions, and verify treatment effectiveness.
- Provides a necessary tool for evaluation of natural attenuation as a treatment alternative.

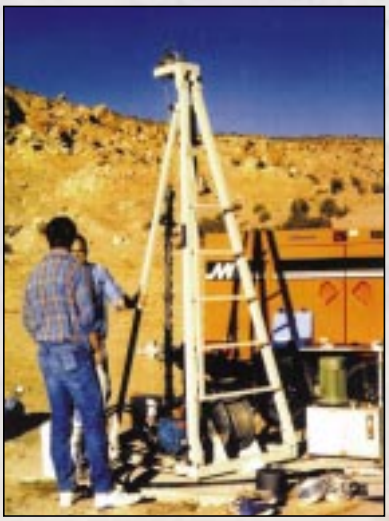
Accomplishments:

- Performed aseptic subsurface sampling in support of Test Area North (TAN) cleanup activities at the INEEL. Information used to establish protocols for enhanced in situ bioremediation.
- Determined the broad distribution of naturally occurring TCE-degrading microorganisms in the larger dissolved phase contaminant plume at TAN.
- Verified the presence of dissolved methane, a nutrient needed to sustain TCE-degrading microbes, in the Snake River Plain Aquifer at TAN, thus supporting a natural attenuation alternative in the proposed Record of Decision.

Aseptic sampling of fractured rock

Naturally-occurring TCE-degrading microorganisms may naturally attenuate the TAN TCE plume at low concentrations





Understanding the chemical and microbial conditions in the subsurface helps identify potential treatment solutions

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Environmental Management Science Program

Science Advancing Solutions

for Subsurface Contamination

Design and Development of a New Hybrid Spectroelectrochemical Sensor

Co-Investigators:

William R. Heineman,
Carl. J. Seliskar,
Thomas H. Ridgway,
University of Cincinnati

Samuel A. Bryan,
Timothy L. Hubler,
Pacific Northwest National Laboratory

Project Number:
70010

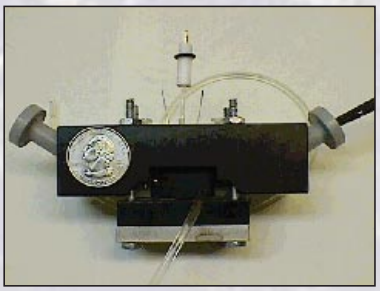
Science Category:
Analytical Chemistry and Instrumentation

Value to EM

- Aid in the characterization of complex waste material associated with DOE site cleanup
- On-site monitoring of collected and prepared samples for field evaluation
- Enhanced selectivity over currently available conventional sensors
- Monitoring of subsurface water and vadose zone

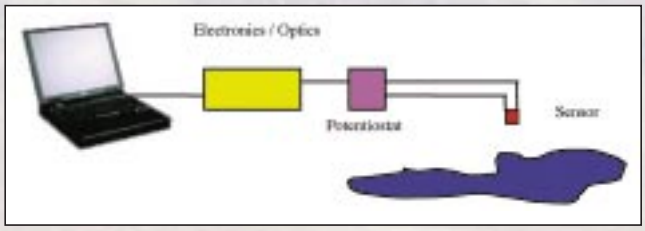
Accomplishments

- Concept demonstrated with detection of ferrocyanide, $Re(DMPE)_3^+$, $Ru(bipy)_3^{2+}$, and methyl viologen
- Selectivity against direct interferences demonstrated
- Signal averaging to achieve lower detection limits demonstrated
- Prototype instrumentation package to control electrochemical modulation and optical readout developed
- Sensor for detection of ferrocyanide in Hanford U-Plant 2 simulant solution demonstrated
- Sensor package (microcell and instrumentation) for demonstration on ferrocyanide in waste tank sample at Hanford developed
- This sensor has been successfully tested on technecium at concentrations ranging from 1-1,000ppm and has the possibility of being modified to detect other groundwater contaminants



This prototype sensor has a sample volume of 800 µl. The blue LED provides a simple light source and the working electrode consists of an indium tin oxide slide coated with a charge selective film.

The Virtual Software interface for spectro-electrochemical sensor allows for remote control of sensors and remote monitoring of sensor response.



Remote sensing can be achieved with the use of a portable computer connected to the cell through a module housing the electronics for data acquisition.

Science Advancing Solutions

for Deactivation and Decommissioning

TRU Decontamination with Plasma Etching

Principal Investigator:
Dr. Robert F. Hicks,
UCLA

Project Number:
54914

Science Category:
Materials Science

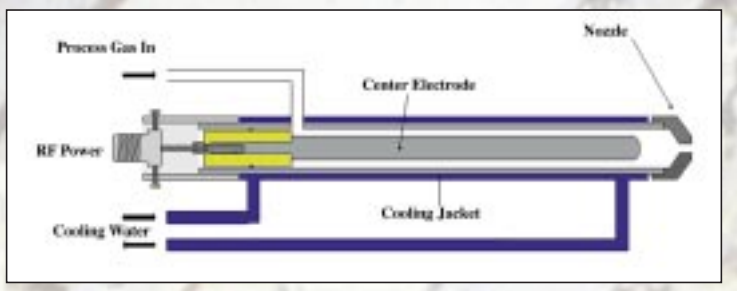
Value to EM Cleanup:

- Decontamination of TRU contaminated waste
- Low-pressure Low-temperature operation
- Cleaning rate of 1/2 ft^2/minute
- Low operating cost <$5/$ft^2$
- Low capital equipment cost <$100K
- No secondary waste
- Field Mobile

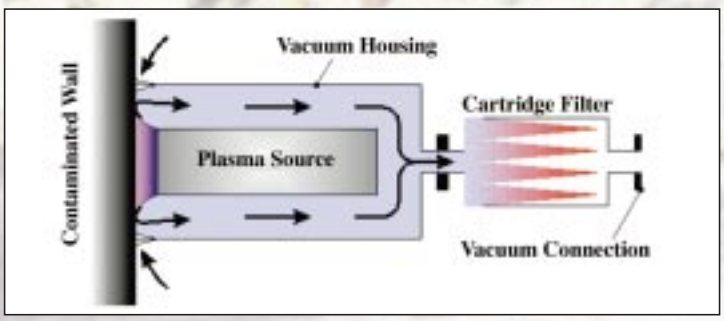
Accomplishments:

- We have demonstrated removal rates of tantalum, a surrogate for plutonium, in excess of 6.0µ/min.
- Vast improvements in the operability and reliability of the plasma source have been made.
- We have scaled up the source from a reactive beam area of 1.0 cm^2 to over 1.0 ft^2
- We have characterized the physics and chemistry of the atmospheric-pressure plasma jet: it generates $10^{11}cm^{-3}$ of ions and $10^{15}cm^{-3}$ of reactive neutral species.
- We have identified the surface chemistry of heavy metal etching: the rate is controlled by surface reactions between adsorbed F atoms and a metal fluoride layer.

4" wide decontamination nozzle



Schematic of Atmospheric-Pressure Plasma Decontamination Technology



Conceptual of TRU contaminant collection system

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Environmental Management Science Program

Science Advancing Solutions

for Subsurface Contamination

High Resolution Definition of Subsurface Heterogeneity for Understanding the Biodynamics of Natural Field Systems: Advancing the Ability for Scaling to Field Conditions

Principal Investigator:
Dr. Ernest L. Majer,
Lawrence Berkeley National Laboratory

Project Number:
55264

Science Category:
Microbial Transport

Value to EM Cleanup:

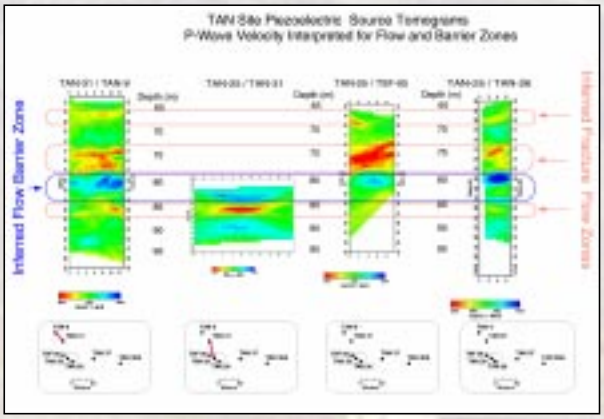
- Provides a cost-effective method for delineating the volume and distribution of highly contaminated fracture zones.
- Can be used to focus remediation efforts, estimate the duration of the remediation effort and to modify the conceptual model for implementing restoration at contaminated sites.

Accomplishments:

- Seismic Crosshole Tomography was successfully employed to image the subsurface between several ground water extraction and monitoring wells at the INEEL Test Area North (TAN)
- Low velocity zones delineated by seismic tomography correlate to fractured intervals known to contain elevated levels of 137Cs and 60Co.
- High velocity zones correlate to intervals of dense basalt with significantly lower concentrations of radionuclides.

Seismic recording van and receiver well with tripod

Sensors being checked for contamination



Seismic velocity tomograms show correlation between fractured flow zones and contamination.

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Environmental Management Science Program

Science Advancing Solutions

for Deactivation and Decommissioning

D&D in Virtual Reality: A near-real-time, semi-autonomous virtualization modeling and imaging system to facilitate tele-operated D&D activities

Principal Investigator:
Dr. Robert J. Schalkoff,
Clemson University

Project Number:
55052

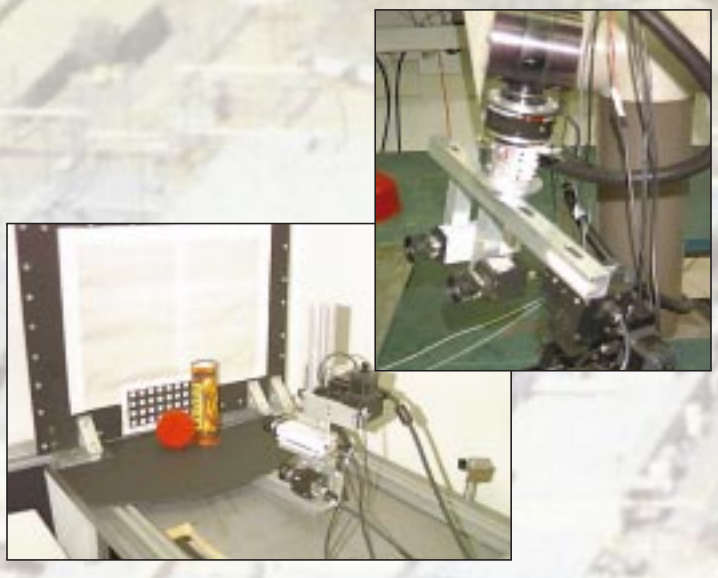
Science Category:
Engineering Science

Value to EM Cleanup:

- 3-dimensional model for Project Planning and Visualization.
- Virtual world operator training.
- Collision avoidance and tele-robotic guidance.
- Waste Packaging and handling optimization
- Reduces worker exposures in hazardous environments.

Accomplishments:

- A fourth generation vision sensing head has been built and tested
- The project is in the process of integrating the imaging system, the Virtual Reality rendering, and the robotics system, into a single operating unit.
- Negotiations are underway to locate a site for phase one testing of the integrated system under more realistic field conditions. The INEEL has expressed an interest in testing at their site in support of the DDROPS.
- Other parties outside the DOE have expressed interest in more refined development of the system.



Laser and camera setup during one of the initial system tests demonstrating the compact size of the scanners.

Image scanning system mounted on robotic arm for remote operations

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Environmental Management Science Program

Science Advancing Solutions

for Subsurface Contamination

Microcantilever Sensors

Principal Investigator:
Thomas G. Thundat
Oak Ridge National Laboratory

Project Number:
60197

Science Category:
Analytical Chemistry and Instrumentation

Value to EM Cleanup:

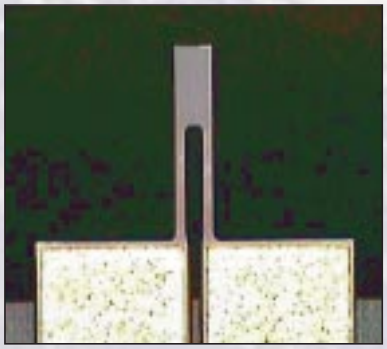
- Basis for real-time, portable, low-cost sensors for remediation and characterization.
- Single platform for chemical, physical, and radiological characterization of ground water and mixed waste.
- Identification of analytes with sub ppb sensitivity.

Advantages:

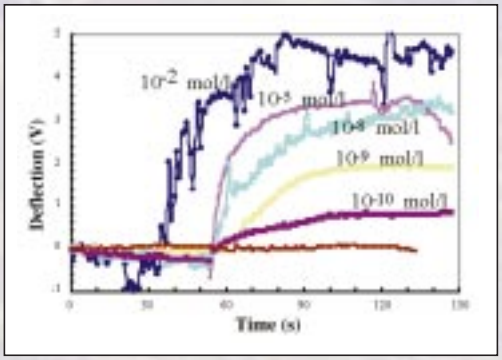
- Operates in solution.
- High sensitivity and selectivity.
- Single platform for physical, chemical, and radiological detection.
- No tagants or labeling necessary.
- Miniature and consumes less power.
- Can be micromachined and mass produced.

Accomplishments:

- Demonstrated detection of Cs^+ with 10^{-12}M sensitivity (dynamic range 10^{-2} - 10^{-12}M). Detected CrO_4^{2-}, Pb, Na^+, and K^+ ions.
- Detected alpha particles.
- Detected Cs^+ in tank waste simulant with high concentration of Na^+ and K^+ ions
- Demonstrated pH detection with high sensitivity (10^{-3} pH units).
- Detection of VOCs such as benzene.

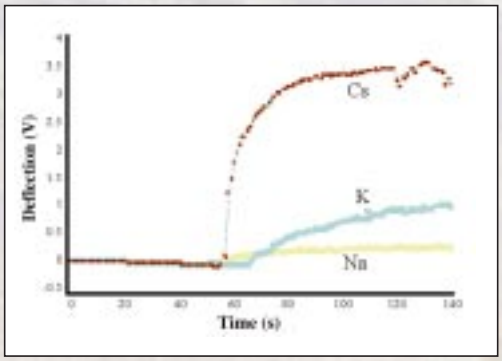


Optical image of a 180µm long silicon mirocrocantilever.



Microcantilever deflection as a function of Cs^+ ion concentration.

Microcantilever bending response for 10^{-5}M solutions of Cs^+, K^+, and Na^+



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Environmental Management Science Program